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AN ENGINEER'S GUIDE TO THE USE OF HUMAN RESOURCES IN ELECTRONIC--ETC(U)
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AN ENGINEERS GUIDE TO THE USE OF HUMAN RESOURCES IN ELECTRONIC SYSTEMS DESIGN

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AN ENGINEER'S GUIDE TO THE USE OF HUMAN RESOURCES IN ELECTRONIC SYSTEMS DESIGN

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WORKING DRAFT

Reviewed by
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FOREWORD

This development effort has been conducted in support of Navy Decision Coordinating Paper, Manpower Requirements Development System (NDCP-Z0109-PN) subproject Z0109-PN.03, Manpower Cost in Systems Design, and under the sponsorship of the Deputy Chief of Naval Operations (OP-01). The objective of the subproject is to apply human engineering technology in incorporating hardware/software/personnel tradeoffs and cost benefit alternatives in all stages of system design.

The objective of this study was to develop a human resources information guide for use by hardware program managers and system designers. This guide will provide manpower and personnel information needed by hardware designers and program managers to assess the impact of candidate system design alternatives on the use and cost of the Navy's human resources. It will also contain analytical tools for making manpower tradeoff assessments during engineering trade studies.

The Contract Monitor for NAVPERSRANDCEN was Mr. Ernest A. Koehler. Major contributions were provided by Dr. David Meister.

THIS REPORT PROVIDES A WORKING DRAFT OF THIS GUIDE FOR EARLY USER EVALUATION. THE FINAL GUIDE WILL BE PUBLISHED LATER THIS FISCAL YEAR.

DONALD F. PARKER
Commanding Officer

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CHAPTER I

INTRODUCTION

INTENDED USE

This guide is intended for use by program managers and system designers early in the conceptual design phase of a new weapon system development. It addresses the impact of various system design alternatives on the use and cost of human resources. It provides manpower and personnel information needed by designers and program managers in making design tradeoff decisions. It also provides analytical tools for conducting manpower tradeoff studies.

DATA PROVIDED

The guide provides data on human resources needed to operate and maintain shipboard radar, sonar, communications, fire control, and data processing systems. For the first time it brings together information on:

1. Most of the specific tasks performed by the technical personnel who operate and maintain these systems:

   .Data Systems Technicians (DS).

   .Electronic Technicians (ET).

   .Fire Control Technicians (FTM).

   .Radiomen (RM).

   .Sonar Technicians (STG).

2. The level of proficiency exhibited in performing each task by personnel of different experience levels (pay grades).
3. The projected availability of these technical personnel, by pay grade, over the next 5-year period, including evidence of critical shortfalls.
4. Billet cost data for personnel of different experience levels, for system life cycles up to 20 years.
5. A listing of NECs (specialist codes) established for each technical rating.

6. A list of manpower and training support-related system design concepts and their estimated relative impacts on such criteria as:

- Numbers of operator and maintainer personnel required.
- Skill levels of personnel required.
- Amounts of training required.
- Costs of tools, test equipment, maintenance facilities, and supply.
- Initial system acquisition costs.
- System reliability and maintainability.
- System operability and operational effectiveness.

THE PROBLEM

The guide addresses the very serious problems of manpower supply, costs, and training requirements, all as related to early system design decisions. The Navy is confronted with serious deficiencies in the timely supply of adequate numbers of skilled manpower for operating and maintaining new and modified weapon systems. Manpower and training support costs are enormous. The identification of manpower and training support requirements typically occurs too late in the weapon system acquisition process (WSAP). The Fleet's estimates of required manpower for new systems often exceed those made by system designers and manpower specialists.

RESPONSIBILITY

Responsibility for consideration of human resources as an element of design clearly rests with system designers and program managers. Historically, the Navy's manpower supply system, which is responsible for manning Navy systems with properly trained and sufficiently skilled personnel, has operated in a reactive mode; that is, by responding as best it could to requirements dictated by system design. Today, this is neither working nor is it affordable. Rather, the situation demands that manpower and training support requirements be considered as design tradeoff variables. This places the responsibility for

early consideration of manpower and training support squarely in the hands of system designers, program managers, and the development agencies. Current Navy policy clearly reflects this fact. Manpower, personnel, and training requirements analyses are required early in the WSAP. Prior to DSARC I, there is to be a manpower and training support concept, an analysis of man-machine functions, preliminary manning estimates, and tradeoff studies (NAVSEAINST 5311.1, 14 June 1977). See Figure 1.

NUMBERS AND SKILL LEVELS

Early design tradeoffs must address not only numbers of required personnel but the skill levels likely to be available. The primary factors driving all manpower costs are the number and complexity of operator and maintainer tasks to be performed, and the frequency with which they must be performed. These factors determine:

1. The number of maintenance and operator personnel required.
2. The required aptitude levels of these personnel.
3. The experience levels required to perform satisfactorily.
4. The amount of general and specialized training required.

AN INFORMATION GAP

Designers and program managers need information they do not presently have. System designers need, but have little, specific information concerning the skill levels and availability of the personnel who will be called upon to operate and maintain new systems. Although often cited as a source of skill level information, currently used documents (Navy Enlisted Manpower and Personnel Classification and Occupational Standards, NAVPERS 18068D, Sections I and II) are too general to serve as guides to system design decisions involving manpower and training support tradeoffs. A stronger link is needed between system design concepts and their manpower, skill level, and training consequences. The largest unknown in all manpower prediction models and Ship's Manning Document predictions is what "skill level" really means in terms of system operation and maintenance.

MAJOR RDT&E PROGRAM PHASES	CONCEPTUAL PHASE	VALIDATION PHASE	FULL SCALE (ENGINEERING) DEVELOPMENT	PRODUCTION/DEPLOYMENT
PRIMARY DECISION POINTS	DSARC I	DSARC II	DSARC III	
MANPOWER, PERSONNEL, AND TRAINING REQUIREMENTS	. M, P&TS Concept . Analyses of Man/Machine Functions . M, P&TS Input to Project Master Plan . Preliminary Manning Estimates for equipment/systems . Trade-Off Studies for equipment/systems . Monitor & Identify M, P&TS Problem Areas	. Draft Navy Training Plan (NTP) . M, P&TS Input to Integrated Logistic Support (ILS) Plan . M, P&TS Input to Requests for Proposal (RFP) . Trade-Off Studies for equipment/systems . Monitor & Identify M, P&TS Problem Areas	. Preliminary Ship Manpower Document (SMD) or Information (SMI) . Navy Training Plan Conference . Update NTP . Draft Crew Phasing & Scheduling Plan . New NEC Requirements . Update M, P&TS Section to ILS Plan . POM Manpower Input for IOT&E, TECH-EVAL/OPEVAL, & to Support Fleet Deliveries . Develop MP&TS Contractor Evaluation Criteria . Monitor & Identify M, P&TS Problem Areas	. Update and Refine SMD/SMI . Update and Refine NTP . Refine M, P&TS Section to ILS Plan . M, P&TS Evaluation Criteria for IOT&E . Monitor & Evaluate Contractor M, P&TS . Finalize Crew Phasing & Scheduling Plan . Monitor & Identify M, P&TS Problem Areas

* Typical products/actions. Specific outputs and time phasing may vary as mutually agreed.

Figure 1. Types of MP&Ts at each stage of acquisition process* (NAVSEAINST 5311.1, 14 Jun 77).

CHAPTER II

DESIGNING IN RELATION TO HUMAN RESOURCES

CENTRAL ROLE OF TASKS

The primary factors driving all manpower costs are the number and complexity of operator and maintainer tasks to be performed, and the frequency with which they must be performed.

These factors determine:

- The number of maintenance and operator personnel required
- The required aptitude levels of these personnel
- The experience levels required to perform satisfactorily
- The amont of general and specialized training required

The objectives of the designer should generally be to minimize manpower lifecycle costs by minimizing these four items. Consequently, the basic orientation of this guide is toward assessing the impact that various conceptual designs have on the tasks that must be performed by operator and maintenance personnel.

TASK DIFFICULTY

From one-half to two-thirds of the technical personnel assigned to operate and maintain surface ship radar, sonar, communications, fire-control, and data systems will be in their first enlistment. Most will

be 3rd class petty officers (Grade E-4). Design for operability and maintainability should focus on the skill levels of these personnel. Yet, both reports from the Fleets and data presented in this guide indicate that their capability to perform many required tasks is marginal.

NEED FOR EARLY TRADEOFFS

Various system design concepts have more or less strong impacts on the resulting complexity of operator and maintainer tasks. The manpower and training cost consequences of these concepts need to be traded off against other cost-benefit considerations. This should happen early in the weapon system acquisition process.

DIRECT AND INDIRECT IMPACTS

The complete manpower development process is one of optimizing the manpower requirements for the system under development, establishing the operator requirements for various ship states of readiness, assessing all maintenance requirements, establishing total administrative and hotel support workloads, taking into account the time required for irregular and utility tasks, making allowances for average productivity levels, and so forth (Plato, 1978).

Though the system designer can not control all of these factors, it is important for him to be aware of the many variables in the overall manning equation that he does impact. These variables include the following (Plato, 1975):

1. Operator requirements
2. Preventive and corrective maintenance requirements
3. Facilities maintenance (cleaning, painting, etc.)
4. Administrative and support workload
5. Utility (miscellaneous task and evolution) requirements
6. Training and service diversion requirements
7. Productivity allowance factors
8. Rate/rank and skill requirements
9. Cross-utilization of personnel for various ship conditions of readiness
10. The standard work week as stipulated by the Chief of Naval Operations

The design engineer directly influences items 1, 2, 6, 8, and 9 through the election of various design alternatives. In addition, minimizing the number of system personnel can indirectly affect items 4 and 5. Carlson (1974) has demonstrated the important secondary savings that result from decreased requirements for onboard service and administrative personnel (e.g., commissarymen, ship's servicemen, yeomen, storekeepers, hospitalmen, and so forth). These savings can come about either through a reduction of the absolute number of operator and maintainer personnel on board, which reduces the need for support and administrative personnel, or by transferring a greater portion of the support and administrative burden to tender or shore-based facilities. Since support and administrative personnel constitute 20-25% of a typical ship's crew (Plato, 1978), these additional indirect savings can be substantial.

WHERE THIS GUIDE FITS

Those responsible for manpower and training support historically have played a reactive role to system design as opposed to directly influencing early tradeoff studies. The situation has been largely as depicted within the solid lines of Figure 2. The Navy personnel system has responded to the output of the traditional design cycle supplying, as best it could, the number of personnel required at each skill level and their required training support.

System lifecycle costs are largely determined by design decisions made prior to DSARC II. Therefore, if personnel costs are to be reduced or minimized, this must be a consequence of manpower and training support tradeoffs conducted early in the design cycle. Information and procedures are provided in this guide, shown within the dashed lines of Figure 2, that can be used in conducting the appropriate tradeoff analyses.

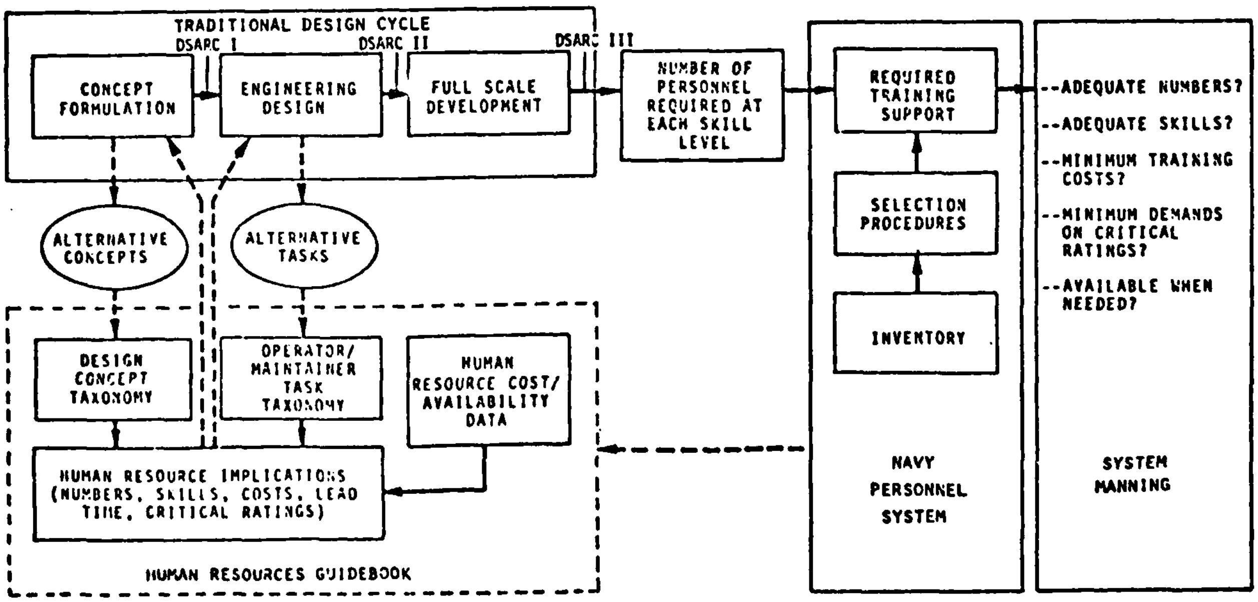


Figure 2. Relationship of the Human Resources Guidebook to system design.

NINE BASIC QUESTIONS

1. How are manpower and training support requirements affected by various operational and maintenance design concepts under consideration?

2. How do the manpower and training considerations interact with other criteria used in evaluating system design?

3. What types and numbers of Navy personnel are likely to be called upon to operate/maintain this type of system?

4. What is the projected availability of these personnel? Are they likely to be in critically short supply in the time frame of interest?

5. In view of the answers to Questions 1-4, which general design alternative best satisfies both manpower and training criteria as well as cost, potential benefit, and technical risk considerations?

6. What is the impact of the preferred system design on specific operator and maintainer tasks?

7. What skill levels and numbers of operator and maintainer personnel are required to perform these tasks?

8. What operational and maintenance training requirements are generated by the need to perform these tasks? To what extent can these be met by existing, rather than by newly developed, training resources?

9. What are the estimated lifecycle costs for the personnel required to operate and maintain the system? Are these within Navy imposed constraints?

The process by which these questions can be addressed early during the conceptual phase of the weapons system acquisition process is depicted in Figure 3. The questions listed above are shown in the figure together with the applicable sections of the guidebook that can be used to help answer them.

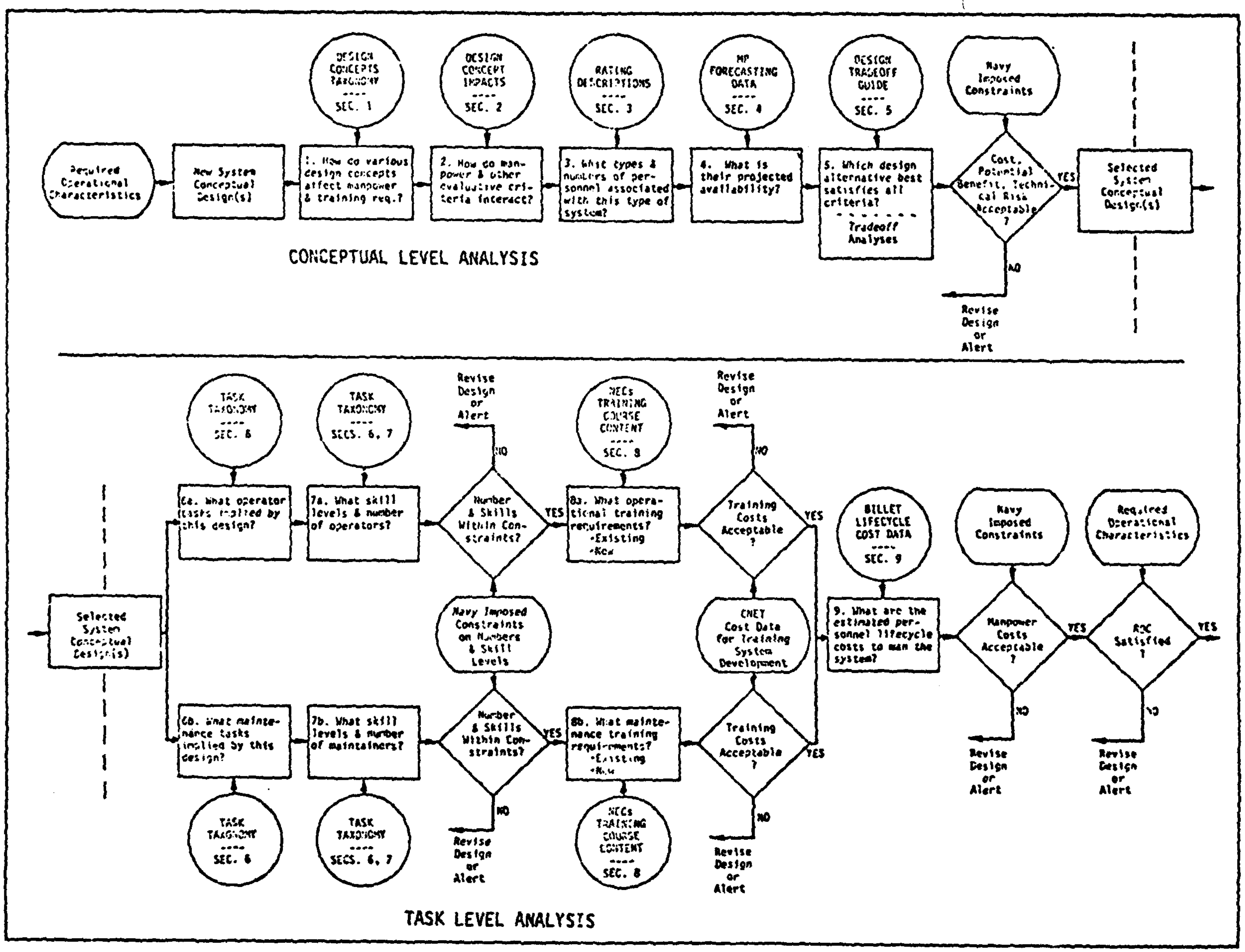


Figure 3. Designing in terms of human resources.

CONCEPTUAL LEVEL ANALYSIS

The upper half of Figure 3 is referred to as "Conceptual Level Analysis." At this level, the analysis is concerned with the impacts of various general system design concepts on manpower, training, and other important criteria. Operational and maintenance design concepts are examined in terms of how they impact operability, maintainability, required personnel skill levels, training requirements, initial acquisition costs, and other evaluative criteria.

TASK LEVEL ANALYSIS

The lower half of Figure 3 is referred to as "Task Level Analysis" since it addresses in considerably more detail the types of operator and maintainer tasks that must be performed in the kinds of systems addressed in this guidebook, the impact of those tasks on the number and skill levels of the operator and maintainer personnel likely to be required, and the question of necessary training system development.

In the final stage, the analysis addresses the predicted manpower lifecycle costs resulting from the number and skill levels of the required personnel identified in the task level analysis. If manpower and training support costs are to be minimized, this must be a consequence of design tradeoffs conducted early in the developmental cycle. An overview of how this guide can be used in following the process outlined in Figure 3 and answering each of the 9 basic human resource and training support questions will now be given.

SECTION 1

DEFINITION AND IMPACT OF DESIGN CONCEPTS

ADDRESSING QUESTION 1

How do various maintenance and operational design concepts affect manpower and training requirements?

This section contains a description of 21 design concepts that impact system maintenance and operator personnel requirements in a variety of ways. The data in this section relate to that portion of the conceptual design process shown in Figure 4.

DESIGN CONCEPT DEFINED

What is a design concept?

As used here, a design concept is defined as a general characteristic of system design that affects the number, skill levels, or training of the operator or maintenance personnel required by the system, as well as other system criteria.

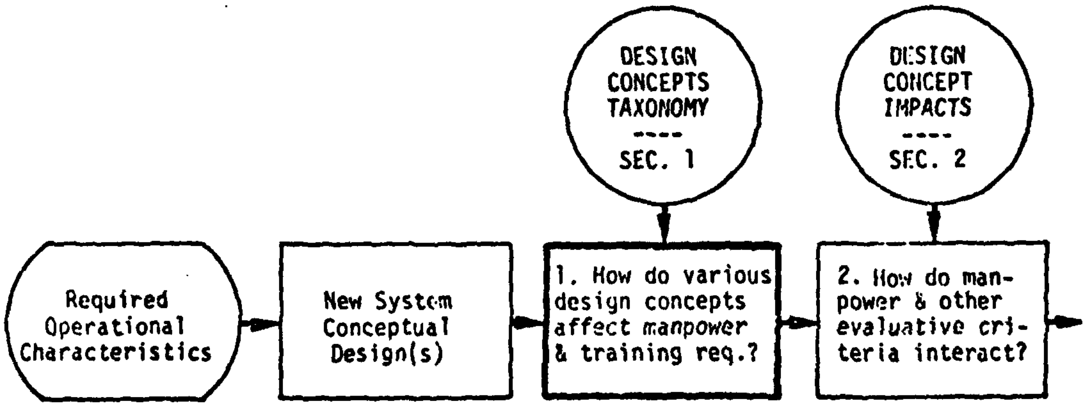


Figure 4. Addressing Question 1.

To the extent possible, while meeting the operational requirement and other constraints, it is assumed that the system designer will utilize design concepts and other, more specific design features that:

1. Minimize the number of operator and maintainer personnel required.

2. Minimize the required skill levels for system operation and maintenance.

3. Minimize new training requirements and specialization codes (NECs).

DIFFERENTIAL IMPACT

> Different design concepts have very different impacts on requirements for manpower, skills, and training.

The 21 design concepts described in this section will be seen to have quite different impacts on various manpower and training criteria as well as on other important evaluative criteria (for definitions of the evaluative criteria used, see Section 2). Some concepts are more "manpower intensive" than others. Further, some concepts that are viewed as beneficial for operability are seen to have potentially adverse consequences for maintainability, clearly implying a need for tradeoff studies.

The impacts of these concepts have been summarized in the form of a profile of beneficial and adverse effects. The profiles, presented in this section, reflect the averaged judgments of 32 Navy engineering personnel who considered the relationship of system design to manpower requirements from widely different perspectives. These engineers included system designers in Navy laboratories, NAVSEC manning experts for new ship construction, human factors engineers in the system commands, research and development personnel concerned with advanced system concepts, and military technical specialists who are daily confronted with the problems of keeping systems operational aboard ship.

Though these personnel did not always completely agree with one another on the various impacts of each design concept, for the most part

agreement was high and the generalizations that resulted are believed to be reasonable. However, the true impact of a design concept may differ somewhat depending on systems-specific characteristics of radar, sonar, fire control, communications, and data processing systems. Where disagreement was substantial concerning the impact of a design concept, this is shown by a Δ at the appropriate place on its profile.

A list of the 21 design concepts is given in Table 1. To provide an overview, those that were judged to have particularly strong impacts on manpower requirements, either positive or negative, have been so identified. However, it is important that the reader become acquainted with the definition of each concept and its full profile on the pages that follow.

INTERPRETING THE PROFILES

How are the design concept profiles used and interpreted?

The scale values shown on the profile sheets reflect the average percentage improvement (or degradation) to be expected, in the view of the judges, in system operation or maintenance as a consequence of employing each design concept.* The referent for this percentage value is always the baseline system described in conjunction with each design concept.

For example, if the designer is interested in the profile for Built-In Troubleshooting Logic Aids, he will turn to page 1-26 where both this concept and the baseline concept are defined. The profile, on the facing page, then shows that a system employing this design concept, compared to a comparable system not employing it, can be expected to:

*The method by which these scale values were computed is described in Dick, R. A., Wylie, C. D., Mackie, R. R., & Ridihalgh, R. R. Research leading to the development of a guidebook on the use of human resources in electronic system design (Tech. Rep. 2702-2). Goleta, CA: Human Factors Research, Inc., 1979.

TABLE 1
RELATIVE IMPACT OF 21 DESIGN CONCEPTS ON SYSTEM
OPERATIONS AND MAINTENANCE

	Impact On: Operation	Impact On: Maintenance	See Page No.
1. Equipment layout to facilitate maintenance		++	1-8
2. LRUs--No spares			1-10
3. LRUs--Spares with onboard repair		+	1-12
4. LRUs--Spares with remote repair		++++	1-14
5. LRUs--Spares with throwaway maintenance		+++++	1-16
6. "Overdesign" for reliability & maintenance	+	++	1-18
7. Embedded computers		----	1-20
8. Automatic performance monitoring	+		1-22
9. Built-in test equipment	+	+++	1-24
10. Built-in troubleshooting logic aids	+	++++	1-26
11. Automatic fault localization	+	++++	1-28
12. Standard hardware components			1-30
13. Standard hardware--Cards/LRUs			1-32
14. Standard hardware--Functional units			1-34
15. Standard hardware--Subsystems			1-36
16. Operational simplicity	++++	+	1-38
17. Built-in operator performance aids	+++++		1-40
18. Automatic decision making	+++++	----	1-42
19. Automatic information transmit & display	+++	----	1-44
20. Built-in training capability	+++	--	1-46
21. Combined operator/maintainer functions	--	-	1-48

+ 10% or greater beneficial impact on one criterion
++ 10% or greater beneficial impact on two criteria
+++ 10% or greater beneficial impact on three criteria
etc.

- 10% or greater adverse impact on one criterion
-- 10% or greater adverse impact on two criteria
--- 10% or greater adverse impact on three criteria
etc.

- Require about 15% less maintainer skills
- Require about 15% less system-specific training
- Reduce shipboard maintenance man-hours by about 24%
- Reduce MTTR by about 28%
- Improve overall operational capability by about 15%

but also,

- Decrease MTBF by about 5%
- Increase initial system acquisition costs by about 20%

How the data in these profiles can be conveniently used in design trade-off studies is explained in Section 5.

TECHNICAL FEASIBILITY

What is the technical feasibility of each design concept?

From their knowledge of past attempts to implement a given design concept, and the technology upon which such attempts were based, as well as changes in technology that might now be applicable, the judges also estimated the probability of successfully implementing each design concept in the near-term future. Both technical and practical risk that might be involved in implementing a design concept were considered. The results of these estimates are given at the end of each concept description.

PROFILES OF 21 DESIGN CONCEPTS

1. EQUIPMENT LAYOUT TO FACILITATE MAINTENANCE

DEFINITION

This design concept refers to such features as quick, easy access via front panels, quick release fasteners, roll out drawers; extensive, easily understood labeling and coding; test points that are easily accessed and are easy to relate to the appropriate functional unit; and modularization by function.

BASELINE

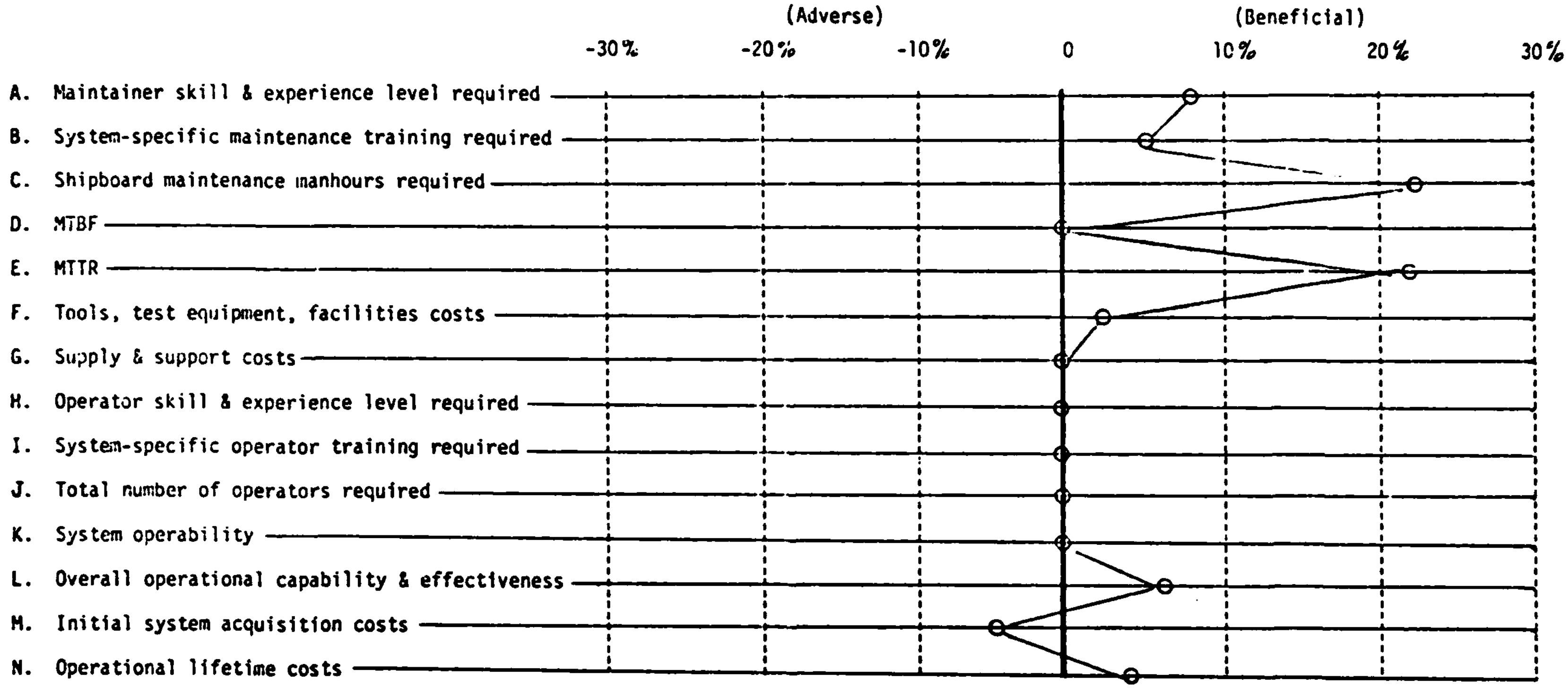
The baseline refers to systems reflecting design practices followed prior to the emphasis on maintainability and human engineering, in which little guidance beyond the engineer's own common sense was applied to equipment layout. Often equipment layout was simply the result of engineering convenience, and size and weight considerations. While new, major systems tend to reflect the approach represented by the design concept, many small systems with low visibility in the Navy are still being built according to the baseline. Rigorous specification of "design for maintainability" principles, and inspection to ensure compliance is usually carried out in the acquisition of large systems, but such considerations are often relaxed or nonexistent in the procurement of smaller systems.

PROFILE

The profile for this design concept shows it to have a pronounced favorable impact on mean time to repair and total shipboard maintenance man-hours. The only adverse impact is a slight increase in initial system acquisition costs.

The technical feasibility of this concept was rated highest (.93) of all concepts examined.

1. EQUIPMENT LAYOUT TO FACILITATE MAINTENANCE



2. LRUs--NO SPARES

DEFINITION

Line replacement units (LRUs) are used in electronic systems; LRUs are removable, plug-in modules that contain relatively small sets of components. In this concept, when repairing a fault, the faulty LRU must be removed from the chassis, repaired onboard the ship, and replaced before the equipment can be brought back on line.

BASELINE

The baseline is essentially the earlier electronics design practice wherein components were permanently mounted in the chassis. While technology has generally moved beyond this stage, the baseline characterizes the design approach used in some of the smaller systems that the Navy continues to acquire today. It is therefore a valid point of comparison for design concepts 2, 3, 4, and 5.

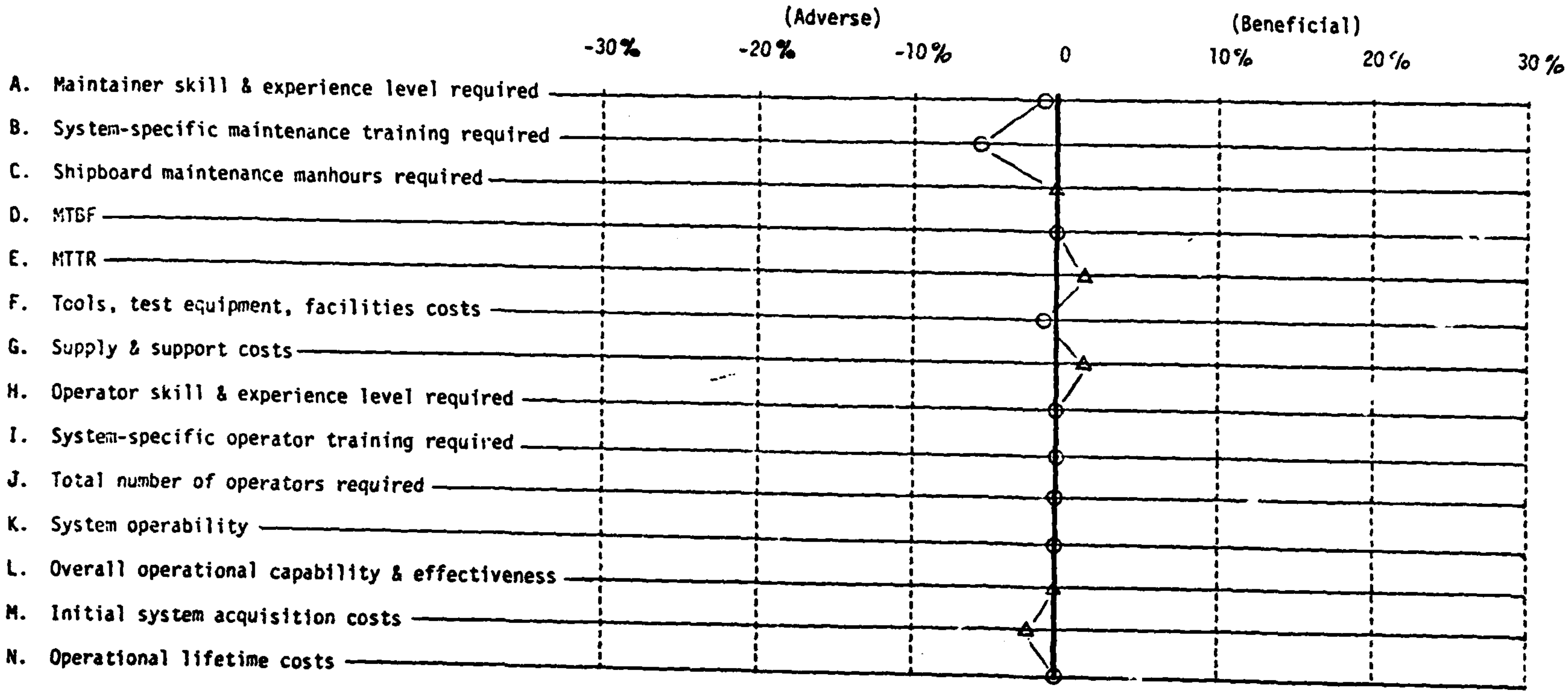
Both the baseline and this design concept, in specifying that repair of faulty LRUs occurs onboard the ship, is in accordance with a historic maintenance philosophy in the Navy of maximizing the amount of repair at the organizational level in order to maximize a ship's self-dependence, reduce the required support network, and reduce the system down time due to possible logistics delays.

PROFILE

The profile for this design concept reflects little or no difference compared to the baseline in its impact on various evaluative criteria. The largest single difference is the adverse impact of this design concept on maintenance training requirements, suggesting that the repair of LRUs may to some extent require greater systems-specific maintenance training than the baseline concept. However, it is notable that there are considerable differences of opinion concerning such important criteria as mean time to repair, total number of maintenance man-hours required, supply and support costs, and so forth. This indicates that there were about as many judges who viewed this design concept as superior to baseline as there were who viewed it as inferior with respect to those criteria.

The technical feasibility of this concept was generally rated high (.84).

2. LRUs--NO SPARES



Δ - Substantial disagreement on impact

3. *LRUs--SPARES/ONBOARD REPAIR*

DEFINITION

In this concept line replaceable units (LRUs) that are faulty are removed from the chassis, replaced with a spare LRU, and the equipment is brought back on line. The faulty LRU again is repaired at the organizational level (onboard the ship).

It should be noted that spare LRUs may sometimes be used as an aid to fault localization by *systematically* substituting spares until the anomalous condition is corrected. Navy technicians call this "Easter egging."

BASELINE

Baseline systems are those that are constructed with components that are permanently mounted in the chassis.

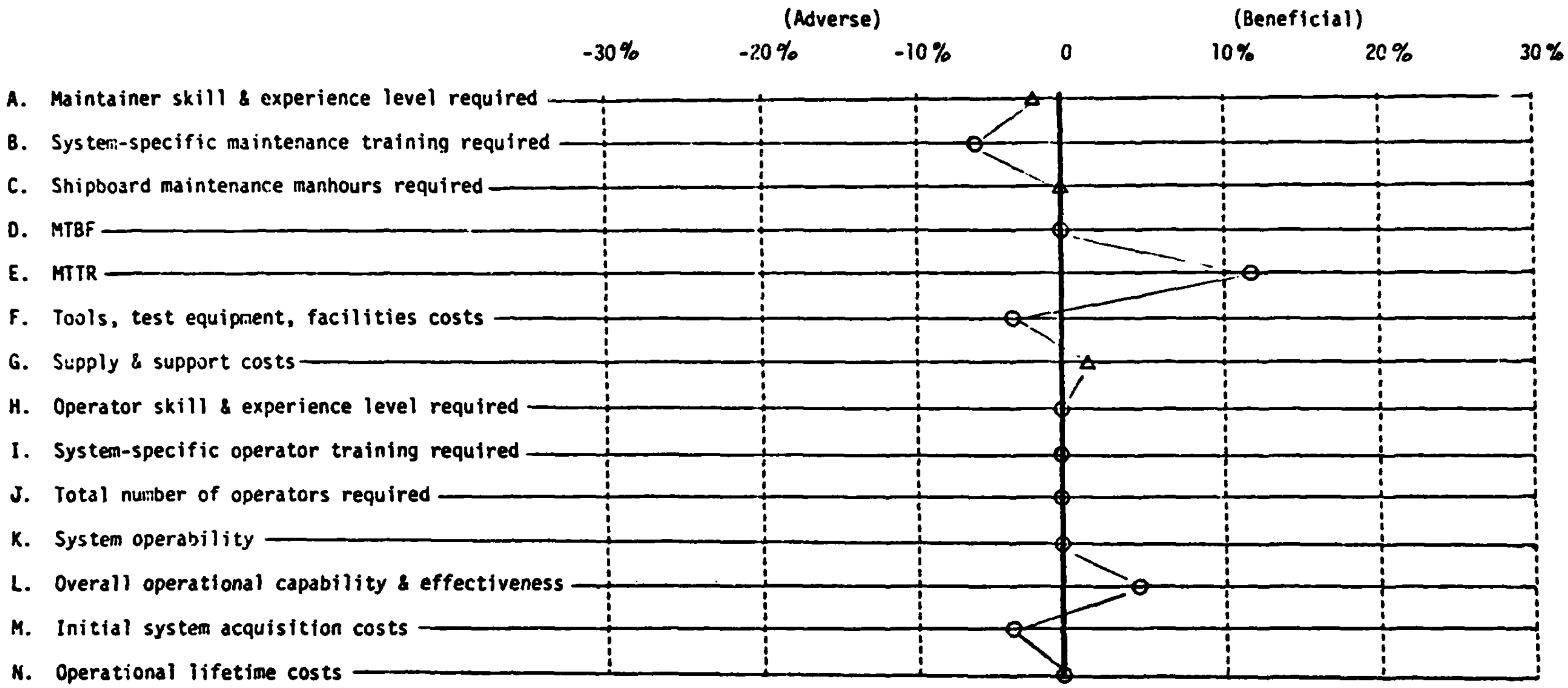
Both the baseline and this design concept specify that the repair of the faulty LRU occurs on-board the ship in accordance with the Navy's "traditional" maintenance philosophy, the objective of which is to maximize the amount of repair at the organizational level in order to increase the ship's self-dependence and reduce the support network.

PROFILE

The major impact of this design concept is seen to be its beneficial effect on mean time to repair. It is notably different in this respect not only from the baseline concept but also from design concept 2. It is similar to design concept 2 in that it is seen to require somewhat greater system-specific maintenance training than the baseline system.

Design concept 3 is regarded as having a relatively high level (.85) of technical feasibility.

3. LRUs--SPARES WITH ONBOARD REPAIR



Δ - Substantial disagreement on impact

4. LRUs--SPARES/REMOTE REPAIR

DEFINITION

This concept is similar to concept 3 in that the faulty LRU is removed from the chassis, replaced with a spare LRU, and the equipment is brought back on line. However, it differs in that the faulty LRU is subsequently sent to a tender or depot for repair as opposed to being repaired onboard.

Faulty LRUs are sent out for repair in accordance with the philosophy of minimizing shipboard manning and facilities requirements by relying upon tender and depot support for essential corrective maintenance. As with design concept 3, spare LRUs may be used as an aid to fault localization by systematically substituting spares until the anomalous condition is corrected.

BASELINE

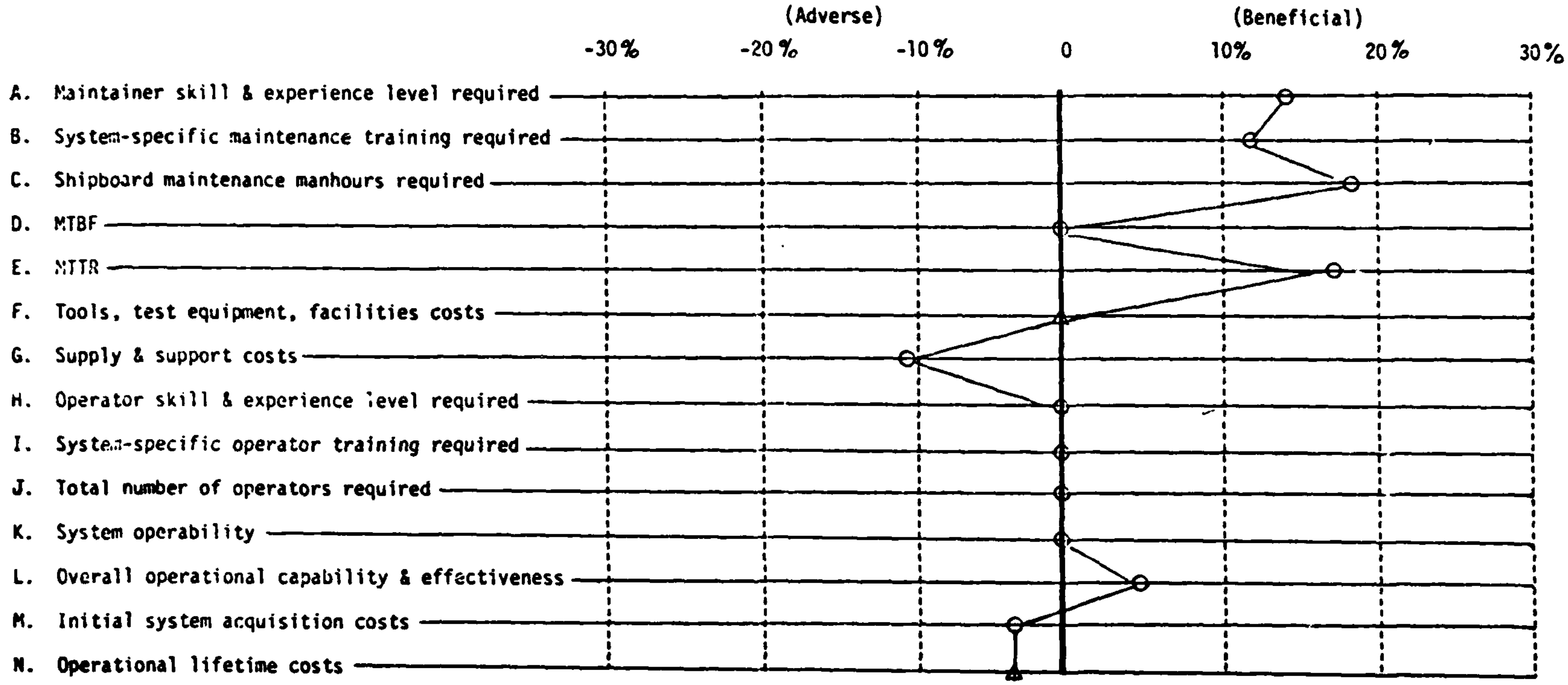
Electronic systems which are constructed with components that are permanently mounted in the chassis.

PROFILE

The profile for this design concept is seen to have strong favorable impact with respect to a number of important criteria: maintainer skill level required, systems-specific maintenance training requirements, shipboard maintenance man-hours required, and mean time to repair. However, it is seen as having a negative impact on supply and support costs.

Design concept 4 is regarded as having a relatively high level of technical feasibility (.84).

4. LRUs--SPARES WITH REMOTE REPAIR



Δ - Substantial disagreement on impact

5. LRUs--SPARES/THROWAWAY MAINTENANCE

DEFINITION

In repairing a fault under this concept, the faulty LRU is removed from the chassis, replaced with a spare LRU, and the equipment is brought back on line. The faulty LRU is then thrown away in accordance with a philosophy of minimizing manning and facilities requirements at the organizational level and at the tender/depot level. This must be accomplished by providing for additional inventory requirements and by minimizing per unit LRU costs.

Like concepts 3 and 4, concept 5 also permits the technician to use spare LRUs as an aid to fault localization by systematically substituting spares until the anomolous condition is corrected.

BASELINE

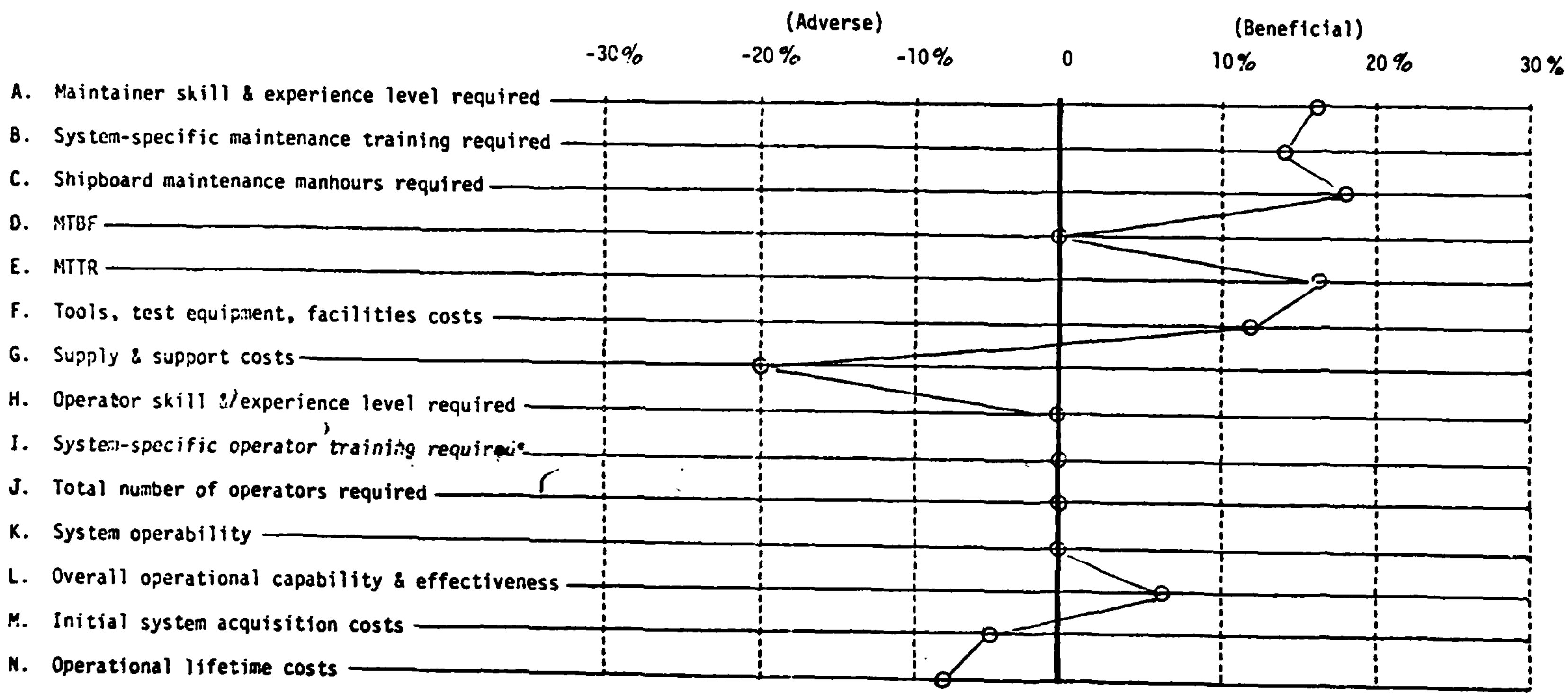
Electronic systems which are constructed with components that are permanently mounted in the chassis.

PROFILE

The profile for concept 5 is very similar to that for concept 4 in its favorable impact on skill level requirements, system-specific maintenance training requirements, man-hours of shipboard maintenance required, and mean time to repair. In addition, it is seen as having a substantial desirable impact on the cost of tools, test equipment, and facilities. However, it is viewed as having a substantial cost consequence in terms of supply and support requirements and an adverse impact on operational lifetime costs.

The technical feasibility of this design concept was rated about average compared to all concepts studied (.80).

5. LRUs--SPARES WITH THROWAWAY MAINTENANCE



6. USE OF "OVERDESIGN" TO ACHIEVE A HIGH DEGREE OF RELIABILITY AND MAINTAINABILITY

DEFINITION

This concept refers to the use of greater than required margins of safety (e.g., higher rated capacitors and resistors than required, ultra-reliable components, redundancy, etc.) to achieve much better total reliability and highly stable circuits that require only infrequent adjustments.

BASELINE

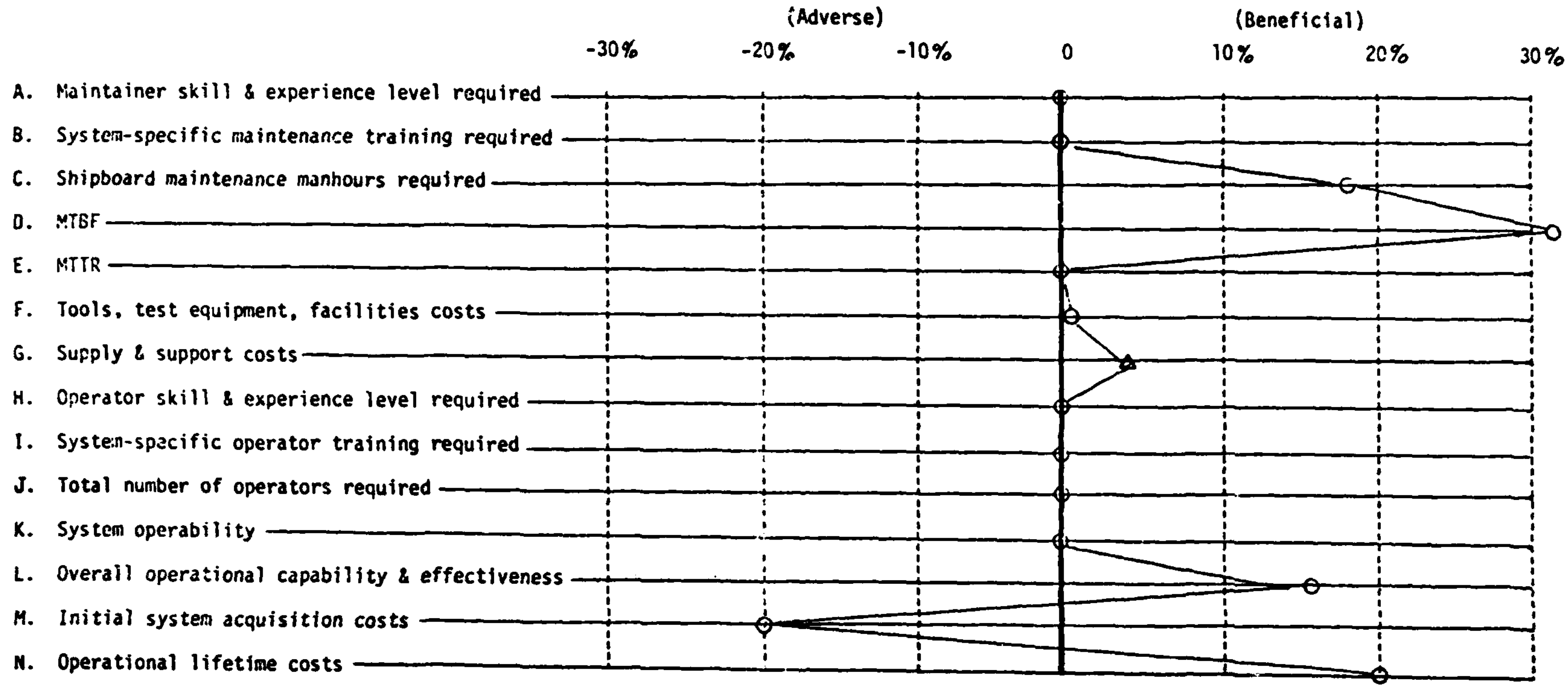
The baseline refers to designing hardware to meet but not exceed prevailing military specifications for reliability and stability.

PROFILE

The profile for design concept 6 reflects an extremely favorable impact on mean time between failures and total shipboard maintenance man-hours required for the system. In addition, it is regarded as having a very favorable impact on overall system effectiveness. While it is viewed as having a substantial adverse impact on initial system acquisition costs, its effect on subsequent operational lifetime costs is viewed as very positive.

Design concept 6 is viewed as having somewhat lower than average technical feasibility compared to other maintenance concepts (.74).

6. "OVERDESIGN" FOR RELIABILITY & MAINTENANCE



Δ - Substantial disagreement on impact

7. EMBEDDED COMPUTERS

DEFINITION

This concept refers to the tendency of some designers to embed microprocessors and other sophisticated digital circuitry in system hardware in order to permit the execution of more sophisticated processing and control functions.

The concept represents one facet of advancing technology--the extensive array of increasingly available microprocessors which is frequently utilized by designers to achieve more efficient, and perhaps more "elegant," solutions to complex requirements. Because the computer-like microprocessors may be inserted into various points in a hardware system, they often do not comprise a separately identified computer subsystem. Thus the Navy may not designate such systems as "computer controlled" and computer specialists are not usually designated to maintain them.

BASELINE

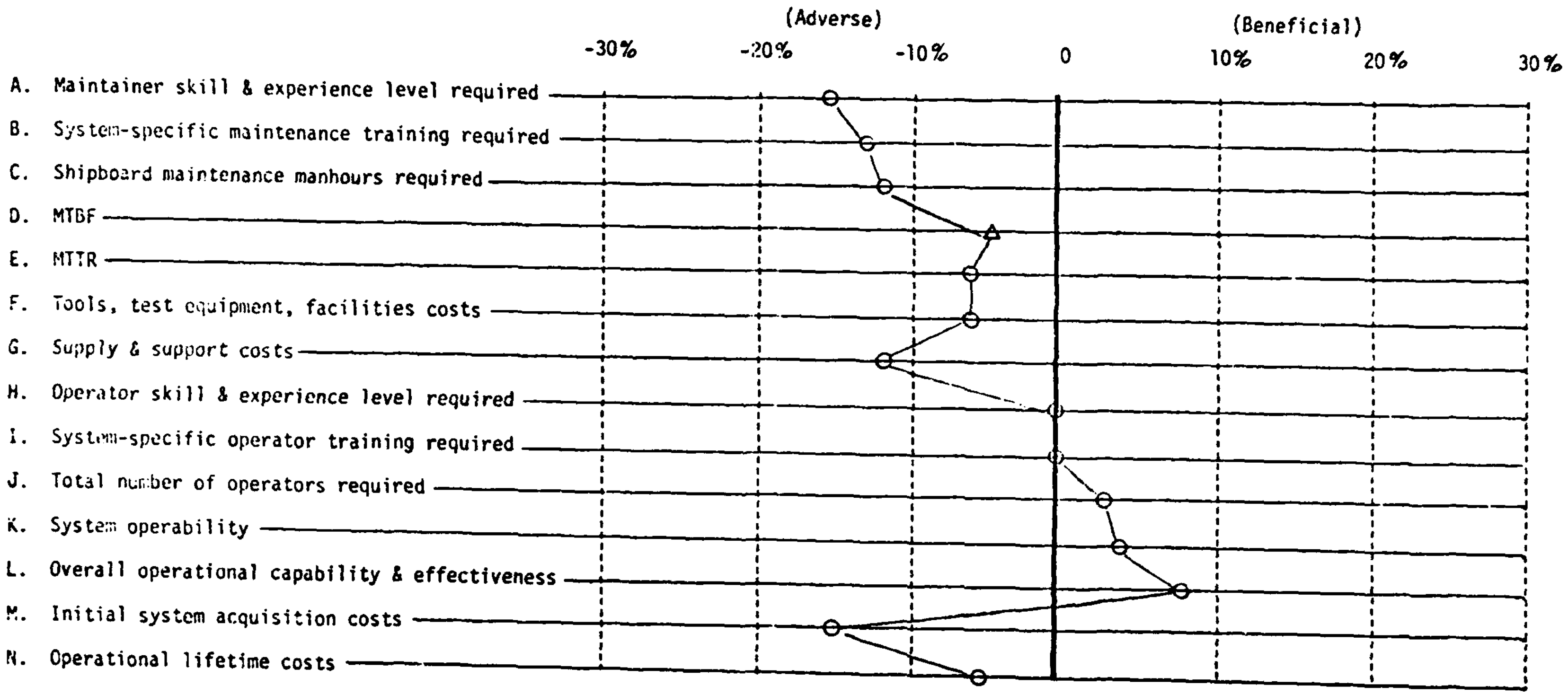
Historically, many electronic systems that have not been computer controlled have relied upon relays, analog devices, and some simple digital devices to accomplish many functions.

PROFILE

The profile for design concept 7 is seen to be negative in many respects. Although it is viewed as having a generally positive impact upon overall system effectiveness, it is felt to have a strong negative impact on required maintainer skill level, training, and maintenance man-hours required, as well as a negative impact on both initial and supply/support costs.

The technical feasibility of this concept is rated high (.85).

7. EMBEDDED COMPUTERS



Δ - Substantial disagreement on impact

8. AUTOMATIC PERFORMANCE MONITORING

DEFINITION

This design concept includes those hardware and software subsystems that perform system monitoring to detect conditions of degraded performance. In some systems automatic performance monitoring is implemented in combination with automatic fault localization. The latter is treated as a separate design concept (11) since it has some distinctly different impacts on a number of system criteria.

BASELINE

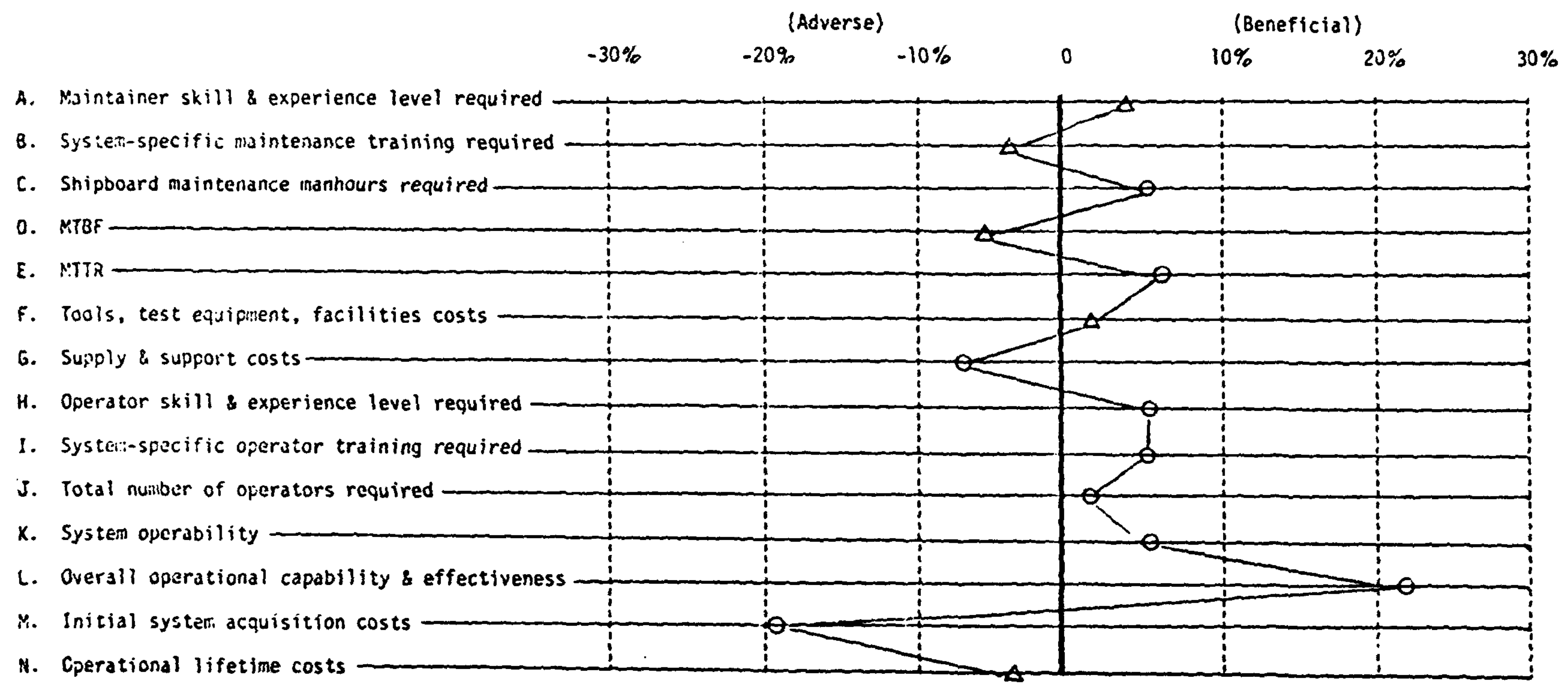
Baseline systems are characterized by nonautomatic detection of degraded performance which depends on an operator or technician inferring from an anomaly in equipment operating characteristics that some aspect of the equipment is out of tolerance or faulty. Such degraded performance may or may not be easily or promptly recognized.

PROFILE

The profile for design concept 8 is shown as having a strong positive impact on overall system effectiveness but at a considerable price in the cost of initial acquisition. It is noteworthy that there were substantial differences of opinion concerning the effect of this design concept on the required skill levels and training of maintenance technicians. Very likely this reflected the view, on the one hand, that automatic performance monitoring features should help to quickly identify malfunctioning or out of tolerance systems but, at the same time, the automatic performance monitoring subsystems themselves may add significantly to the maintenance burden.

Design concept 8 was viewed as slightly below average, compared to other concepts studied, in technical feasibility (.76).

8. AUTOMATIC PERFORMANCE MONITORING



Δ - Substantial disagreement on impact

9. BUILT-IN TEST EQUIPMENT (BITE)

DEFINITION

This concept eliminates much of the need for separate, independent test equipment; the connections between built-in displays and test points are achieved through switch selections.

BASELINE

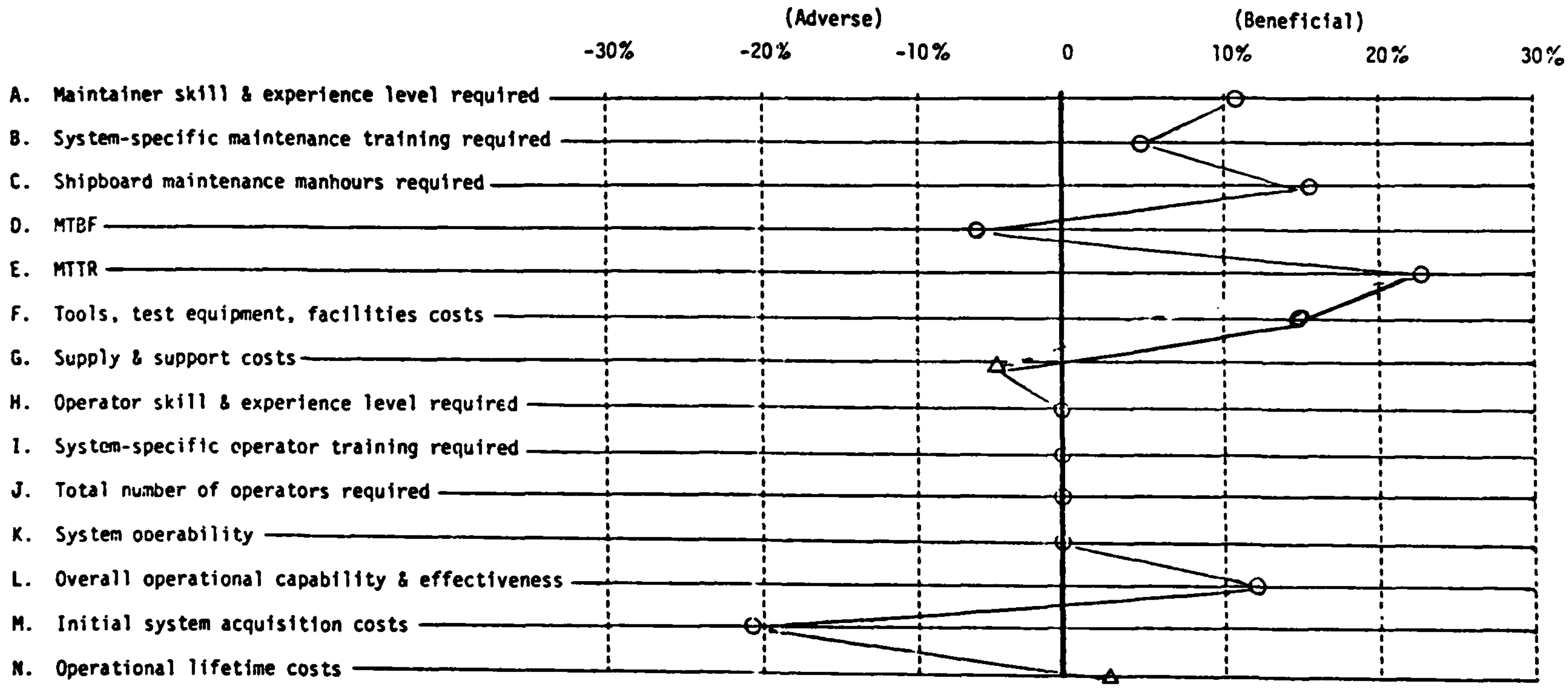
The baseline refers to maintenance and fault localization which is performed using separate test equipment and maintenance documentation. Preventive and corrective maintenance in the baseline system may require considerable time to set up separate test equipment, attach it to appropriate test points, interpret the output, reset for additional test points, and so forth, and eventually to put the test equipment away.

PROFILE

The profile for design concept 9 is seen as having a substantial positive impact on MTTR, shipboard maintenance man-hours required, tools and test equipment costs, skill level of maintenance personnel, and overall system effectiveness. Its principal drawback is viewed as high initial acquisition costs.

The technical feasibility of design concept 9 was judged to be above average (.84).

9. BUILT-IN TEST EQUIPMENT



Δ - Substantial disagreement on impact

10. BUILT-IN TROUBLESHOOTING LOGIC AIDS

DEFINITION

This design concept eliminates much of the usual need for separate maintenance documentation. Computer-based systems are provided with auxiliary software and information displays that guide personnel through preventive maintenance steps and systematic troubleshooting strategies.

The concept refers to the relatively new developments in software aids to maintenance and troubleshooting. Some of these approaches include sophisticated algorithms that take into account an analysis of the reliabilities of all of the hardware components in developing troubleshooting strategies.

BASELINE

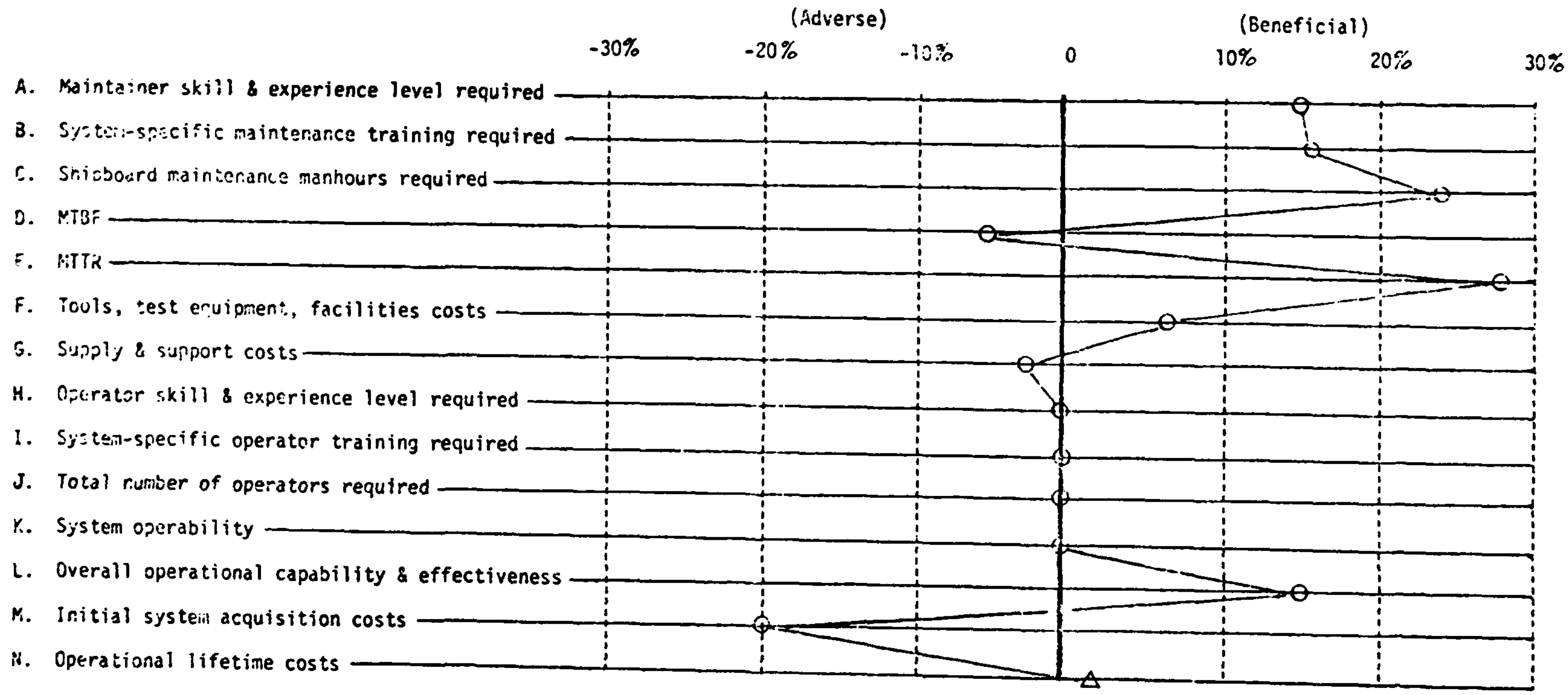
Maintenance and fault localization that is performed using separate test equipment and maintenance documentation. Preventive and, especially, corrective maintenance in baseline systems may require considerable time and skill to find the appropriate documentation, search through it, and apply it in the process of locating faults.

PROFILE

The profile for design concept 10 is seen as being highly positive with respect to MTTR, maintenance man-hours required, skill level of the technicians, and their training. It is also viewed as having a substantial positive effect on overall system effectiveness. Its principal drawback is considered to be high initial system acquisition costs.

The technical feasibility of design concept 10 is considered to be about average (.79) compared to other concepts studied.

10. BUILT-IN TROUBLESHOOTING LOGIC AIDS



Δ - Substantial disagreement on impact

11. AUTOMATIC FAULT LOCALIZATION

DEFINITION

Use of this design concept eliminates the need for separate test equipment and separate maintenance documentation to perform initial fault localization. An automated subsystem is used to perform measurements at various test points and to deduce the localization of faults to some degree of resolution (e.g., 90% of the faults are localized to "ambiguity groups" of not more than 3 PC cards).

BASELINE

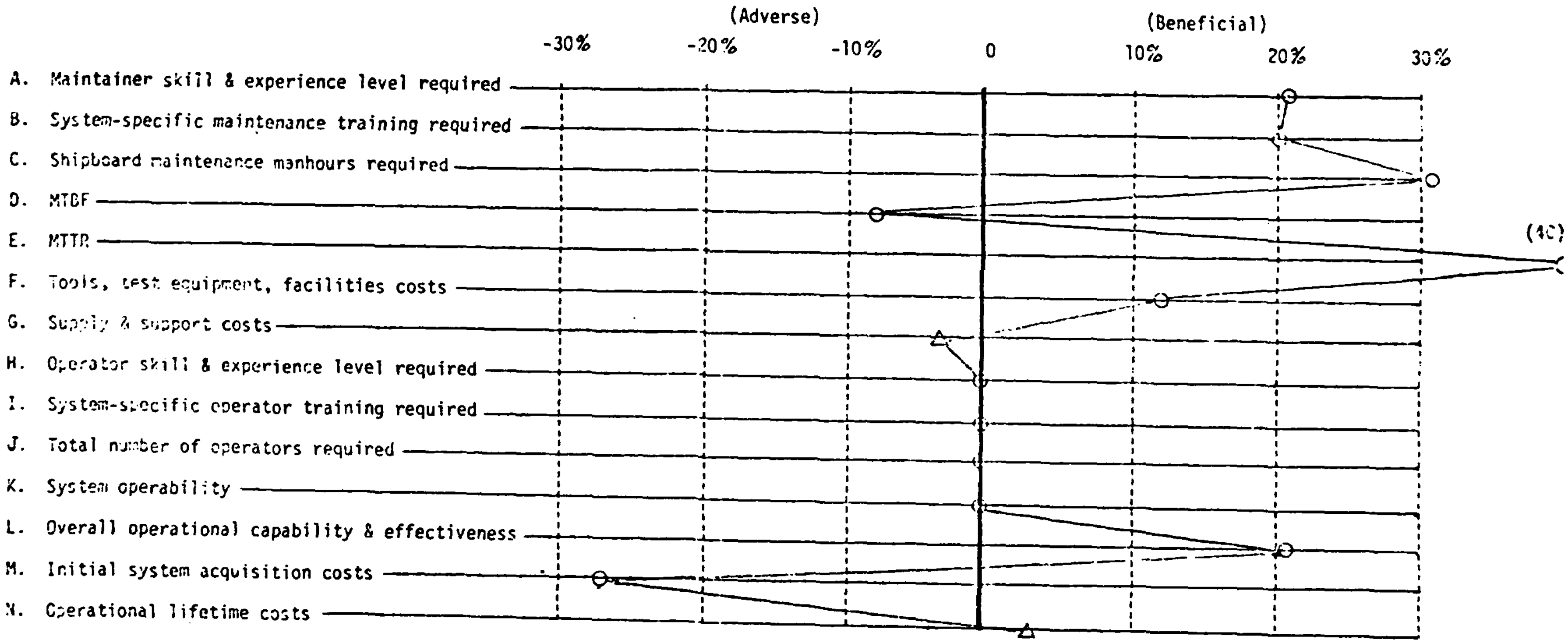
Maintenance and fault localization which is performed using separate test equipment and maintenance documentation.

PROFILE

Design concept 11 is seen to have extremely favorable impacts on MTTR and total required shipboard maintenance man-hours. It also has strong positive impacts on maintenance skill level and amount of training required, as well as on overall system effectiveness. However, it is seen as having a very substantial impact on initial system acquisition costs. It is also viewed by some as having a negative impact on MTBF, suggesting that it may be a source of maintenance problems in its own right.

The technical feasibility of design concept 11 is viewed as somewhat below average (.75).

11. AUTOMATIC FAULT LOCALIZATION



Δ - Substantial disagreement on impact

12. HARDWARE STANDARDIZATION--COMPONENTS

DEFINITION

In this concept component hardware items such as transistors, resistors, chips, etc., are selected so that they are identical to items used in other shipboard systems and assemblies. Component selection is substantially influenced by their availability in the Navy supply inventory. The concept argues for ensuring, at least, that small components are standard and interchangeable among shipboard hardware assemblies.

BASELINE

Selection and use of components in an assembly of hardware is made without regard for commonality across other hardware systems found aboard ship. Little consideration may be given to the availability or obtainability of components in the existing Navy inventory.

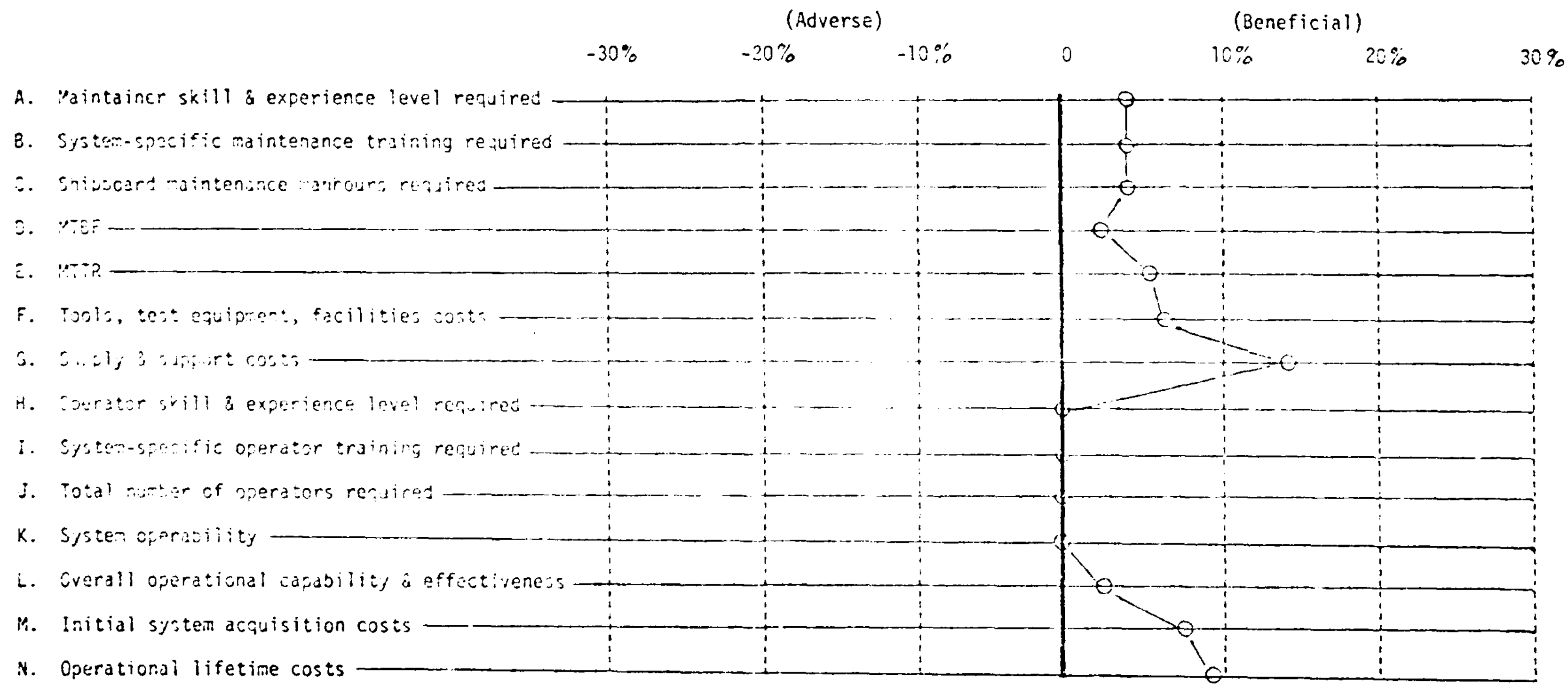
The baseline refers to a common design practice where specifications do not closely regulate the choice of hardware items that are available to the designer. Hardware designers often prefer to utilize their own unique approaches to hardware functions, because they feel able to develop new, cheaper, or "better" solutions to problems, or because they are comfortable with their own proven approaches. Thus one contractor's hardware is often much different from another's, even in systems designed to perform to the same specifications.

PROFILE

The profile for design concept 12 is seen to be largely positive with the strongest favorable impacts occurring on supply/support costs and operational lifetime costs. The impacts on maintenance personnel are seen as positive but small.

The technical feasibility of design concept 12 is viewed as high (.86).

12. STANDARD HARDWARE COMPONENTS



13. HARDWARE STANDARDIZATION--CARDS/LRUs

DEFINITION

Assemblies of hardware items such as standard electronic modules (SEMs), standard cards, etc., are selected so that they are identical to items used in other shipboard systems and are available in the Navy supply inventory. The concept argues for ensuring that cards and LRUs, at least, are standard and *interchangeable among* shipboard hardware assemblies.

BASELINE

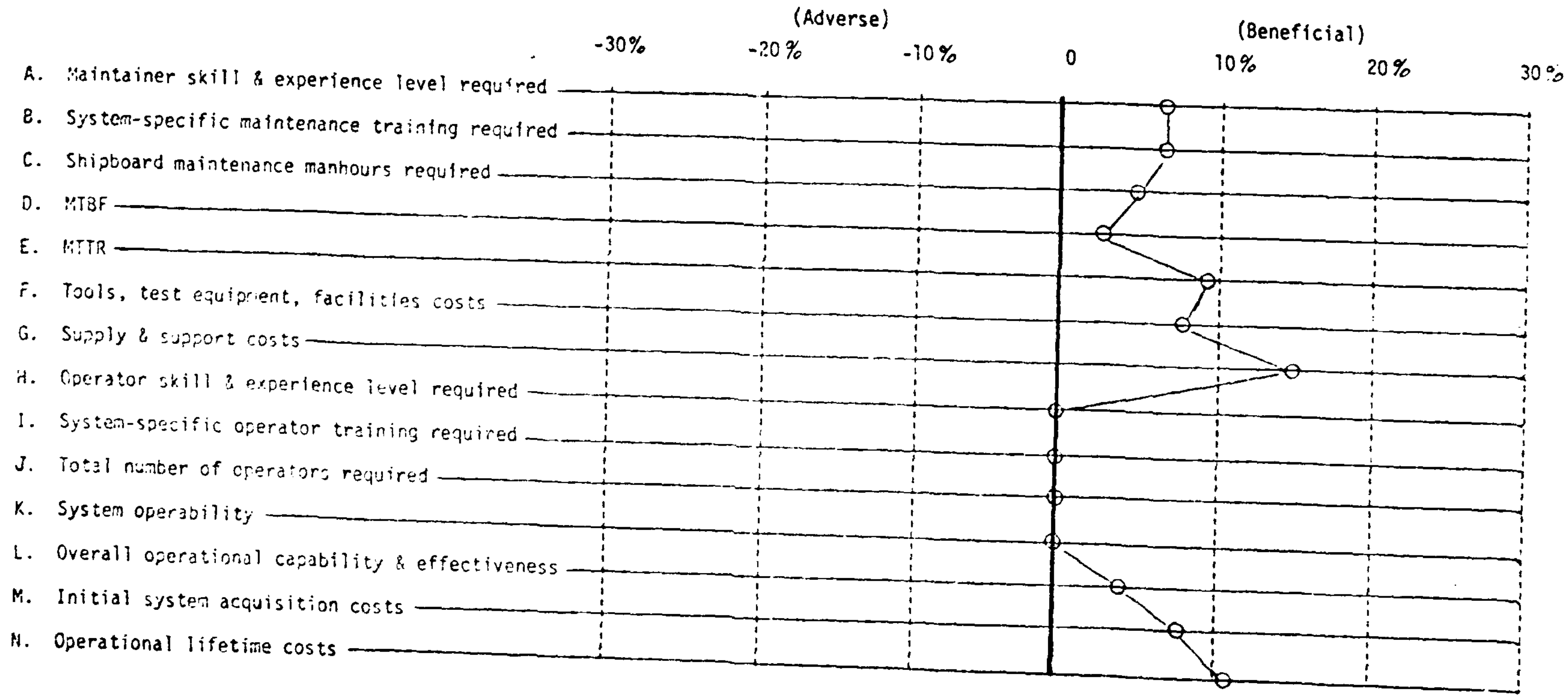
The baseline refers to the practice of selecting and using cards and LRUs in an assembly of hardware without regard for *commonality across other* hardware systems found aboard ship. Little consideration is given to the availability or obtainability of cards and LRUs in the *existing Navy inventory*. Again the baseline reflects a common design practice wherein specifications do not closely regulate the choice of hardware items that are available to the designer. Hardware designers often prefer to utilize their own unique approaches to hardware functions because they can then develop new cheaper or "better" solutions to problems or because they are comfortable with their own proven approaches. For example, SEMs are said by some to be inefficient in terms of weight and size, and to lag the state of the art.

PROFILE

The profile for design concept 13 is seen as one of positive impact, particularly on supply/support costs, operational lifetime costs, and MTTR. Its profile is quite similar to that for concept 12 but somewhat more positive.

Design concept 13 is viewed as slightly above average in technical feasibility (.83).

13. STANDARD HARDWARE--CARDS/LRUs



14. HARDWARE STANDARDIZATION--FUNCTIONAL UNITS

DEFINITION

Under this concept, complex assemblies of hardware items which perform a given function, such as power supplies, amplifiers, and so forth, and which are complete in themselves, are selected so that they are identical to items used in other shipboard systems and are available in the existing Navy supply inventory.

BASELINE

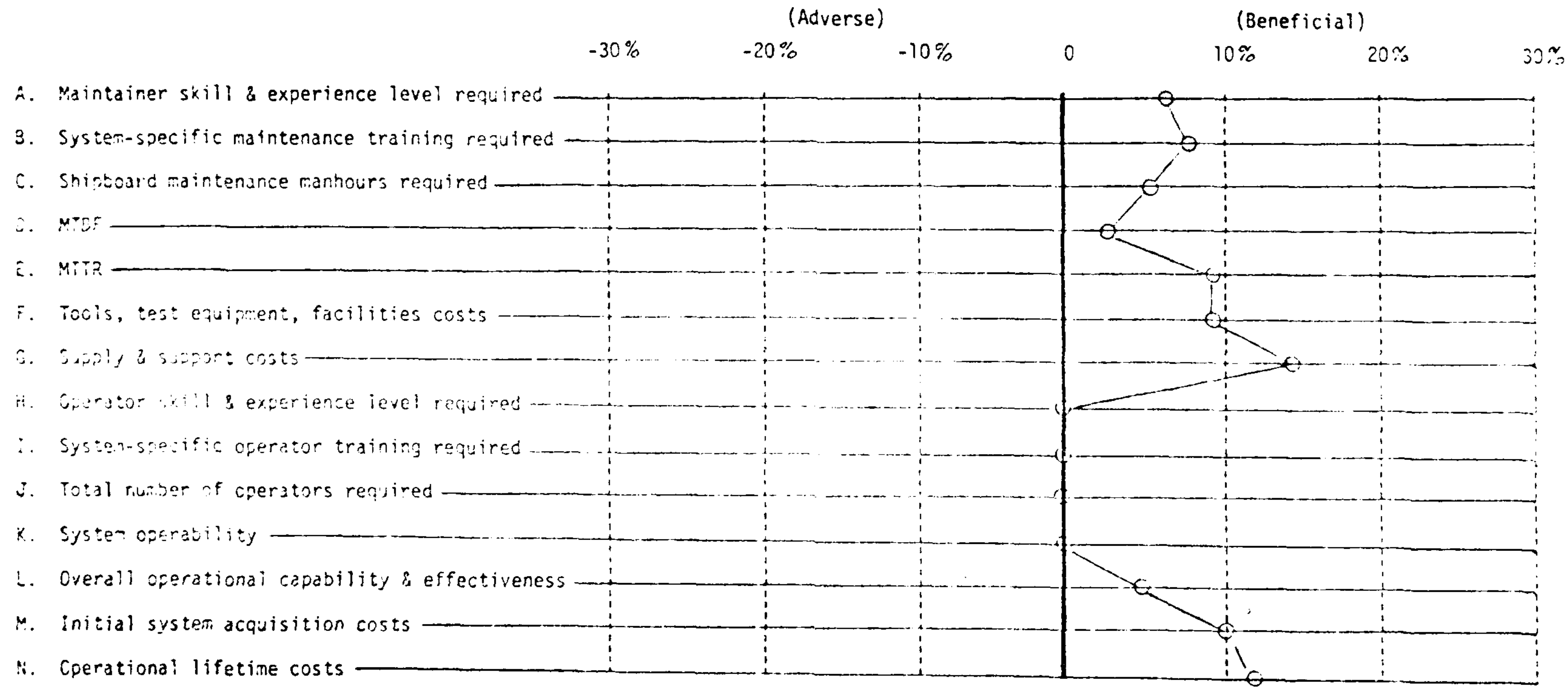
The baseline is characterized by selection and use of functional units in an assembly of hardware without regard for commonality across other hardware systems found aboard ship. Little consideration is given to the availability or obtainability of functional units in the existing Navy supply inventory.

PROFILE

The profile for design concept 14 is seen to be highly similar to that for concept 13 with the most favorable impacts occurring on supply support costs, operational lifetime costs, MTTR, and MTBF.

Design concept 14 is regarded as somewhat lower in technical feasibility than concepts 12 and 13 (.75).

14. STANDARD HARDWARE--FUNCTIONAL UNITS



15. HARDWARE STANDARDIZATION--SUBSYSTEMS

DEFINITION

In this concept, complex assemblies of hardware items which perform a variety of functions and may be operated as a separate unit such as display consoles, computers, magnetic tape units, etc., are selected so that they are identical to subsystems used in other shipboard systems and are available/obtainable through existing Navy supply inventories.

BASELINE

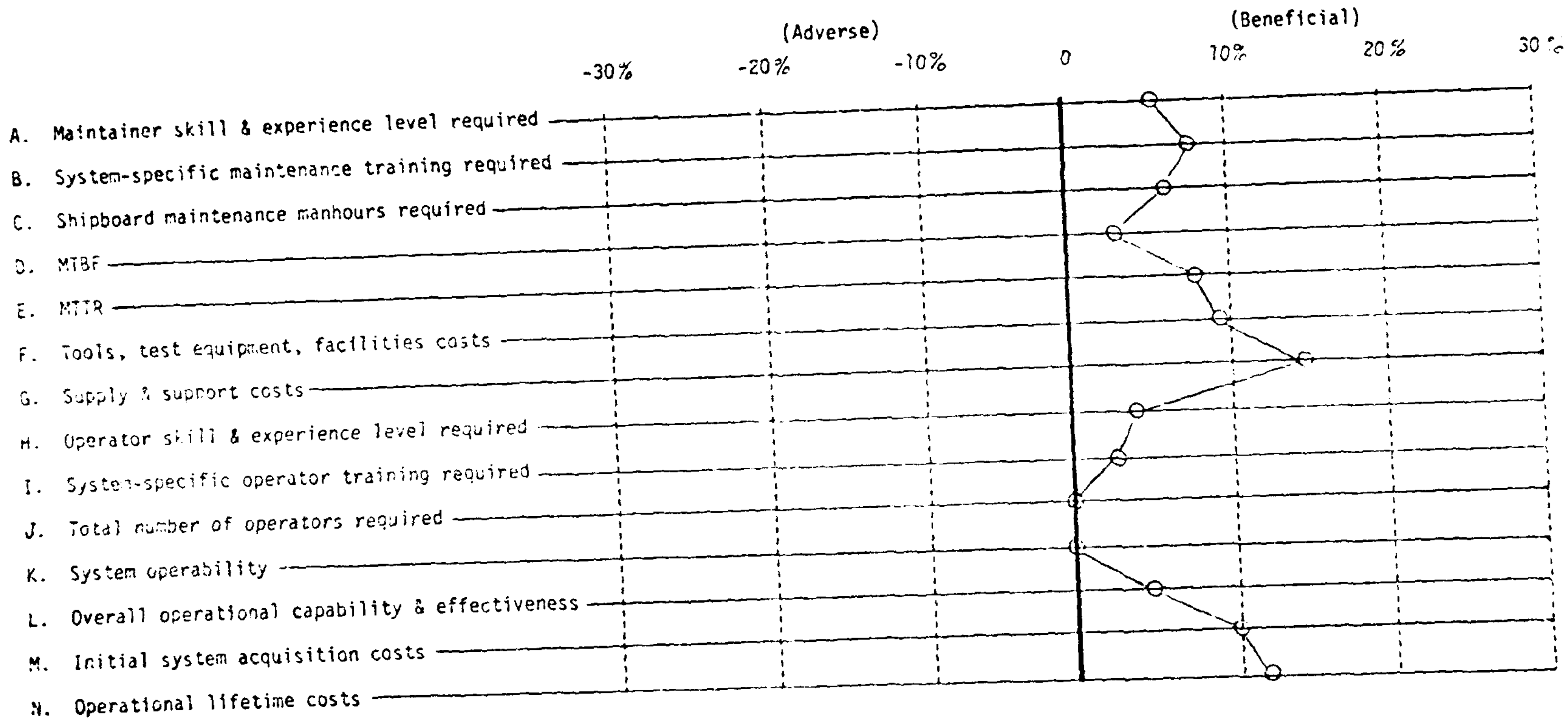
The baseline system involves the selection and use of subsystems within a system without regard for commonality across other systems found aboard ships. Little consideration is given to the availability or obtainability of subsystems in the existing Navy inventory.

PROFILE

The profile for design concept 15 is seen to be virtually identical to that for other concepts involving standardized hardware. However, standardized hardware at the subsystem level for the first time is seen to have a modest positive effect on the training and skill level of operator personnel as well as of maintainers.

The technical feasibility of employing design concept 15 was judged to be somewhat below the average of all concepts (.73), and the lowest of all concepts having to do with hardware standardization.

15. STANDARD HARDWARE--SUBSYSTEMS



16. OPERATIONAL SIMPLICITY

DEFINITION

Under this concept, equipment is designed to simplify the operator's task by minimizing the number of operating options, setup modes, processing parameters, display alternatives, etc.

BASELINE

Some systems are designed so that the operator has many choices of processing parameters, setup modes, and alternative operational configurations. This flexibility allows a properly qualified operator to optimize system operation to best fit changing operational or environmental situations.

The design concept and the baseline system represent two opposing philosophies. The baseline argues for taking advantage of all of the capability that can be engineered into the system, by giving the operator a wide range of modes and controls with which to optimize processing capability. The design concept argues for simplifying operational use by cutting out infrequently used or complex features even though this may sacrifice some potential operational capability.

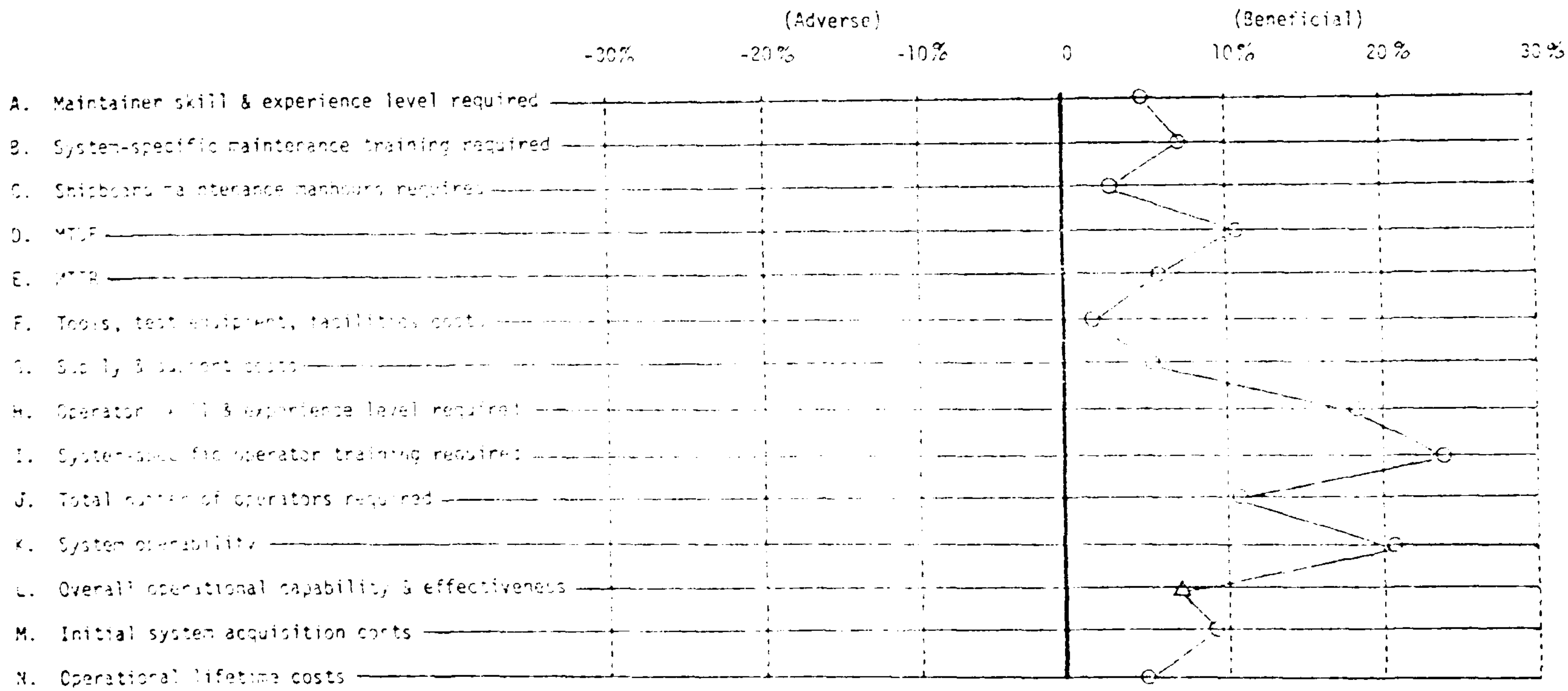
PROFILE

Concept 16 shows a strong positive profile and is viewed as having a favorable impact on virtually all system criteria. Its effects are particularly strong on required operator skill levels, operator training requirements, and system operability. Substantial secondary impacts are seen on the number of system operators likely to be required and on MTBF.

The impact of this concept on overall system effectiveness is generally seen as positive, though there was substantial disagreement on this point. One viewpoint maintains that operational simplicity will enhance system effectiveness by virtue of the fact that personnel with lower skill levels and lesser training will more likely be able to operate such a system effectively. The other maintains that operational simplicity cannot be achieved without a significant loss in overall system effectiveness. Clearly, any conflict between operational requirements and personnel skill requirements generates a major tradeoff issue.

The technical feasibility of concept 16 was rated slightly above average (.83).

16. OPERATIONAL SIMPLICITY



Δ - Substantial disagreement on impact

17. BUILT-IN OPERATOR PERFORMANCE AIDS

DEFINITION

This concept refers to computer-based systems which are provided with auxiliary software to guide the operator through setup sequences and aid him in the acquisition and management of information necessary to perform his tasks.

It includes those systems that provide operator "prompting" during menu selection tasks and other operator input functions. With such aids, systems embodying this concept can coach the operator through relatively complex procedural sequences. After beginning from one of a limited number of initial conditions, the operator has a *small number of alternatives to consider* at each subsequent choice point. By working through a sequence of relatively simple decisions, he *eventually* arrives at a point that is the terminus of a complex decision process. However, this design concept does not relieve the operator of the responsibility of interpreting displayed information and making decisions based upon it.

BASELINE

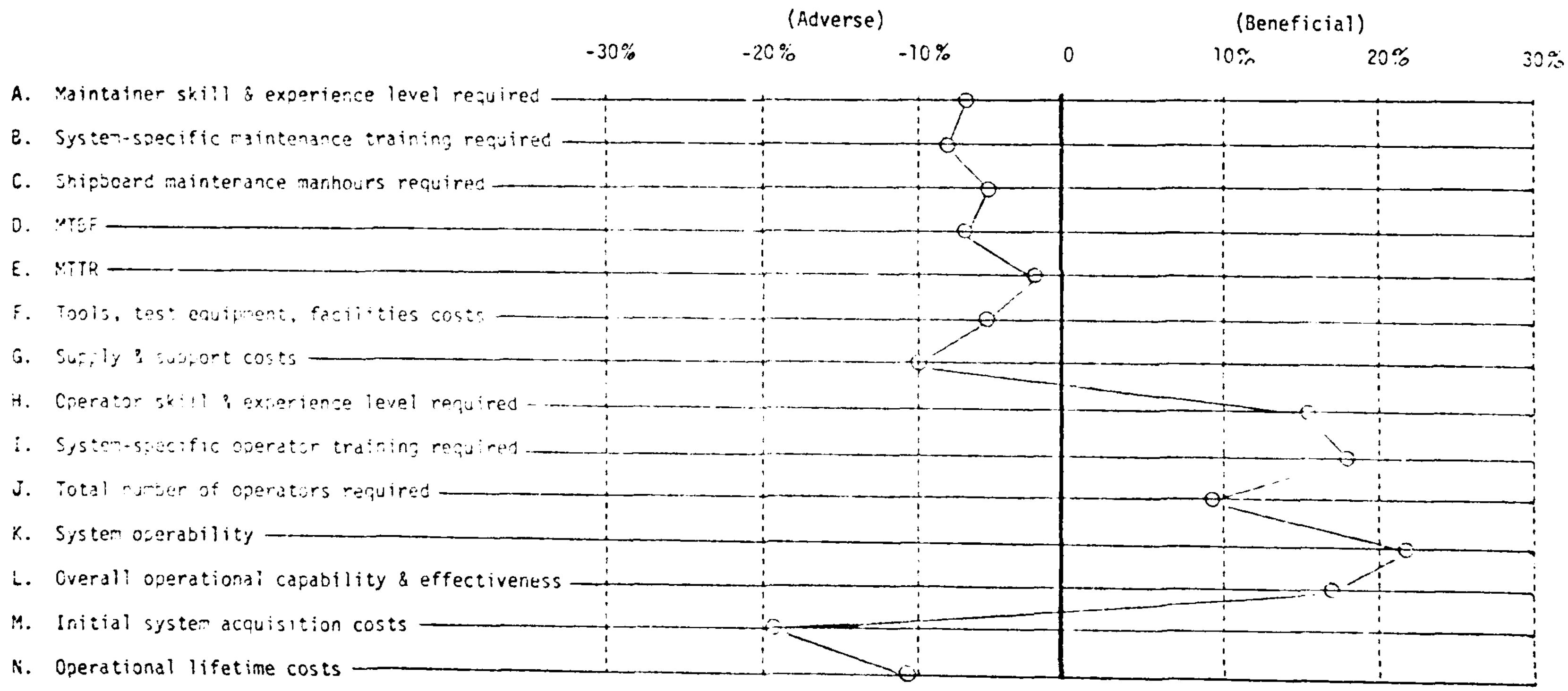
In the baseline system the operator must have complete knowledge of all the inputs required to achieve a certain setup mode or to manipulate and manage data presented by the system. Baseline systems require the correlation, analysis, and interpretation of numerous and complex types of information and rely upon the operator to set up the system to acquire various types of information, interrogate system files, integrate information, interpret it, and make decisions.

PROFILE

Design concept 17 involves a strong mixture of impacts on manpower requirements and training support. There are highly beneficial effects on system operability, overall system effectiveness, operator skill level required, and operator training. In contrast, there are substantial negative impacts on initial system acquisition costs and, to a lesser extent, on operational lifetime costs and supply/support costs. The impacts on maintenance personnel are small but consistently negative.

The technical feasibility of design concept 17 is viewed as about average (.80).

17. BUILT-IN OPERATOR PERFORMANCE AIDS



18. AUTOMATED DECISION MAKING

DEFINITION

This concept applies to computer-based systems in which primary responsibility for selecting and integrating information, interpreting it, and making decisions rests with the system software. The operator is primarily a monitor and an arbitrator of indeterminate cases.

In this concept, the operator sets up the system; then he performs monitoring and housekeeping functions (e.g., purging unwanted data). Theoretically, the operator may override or delay action on a computer decision and he may make decisions in indeterminate cases. In practice, however, many systems with automated decision making do not provide the operator with the variety of displays and information that are provided to operators of manual systems who make equivalent decisions. Thus, it may be argued that the operator/monitor of an automatic decision making system might not have sufficient information to adequately execute overriding and arbitrating decisions.

BASELINE

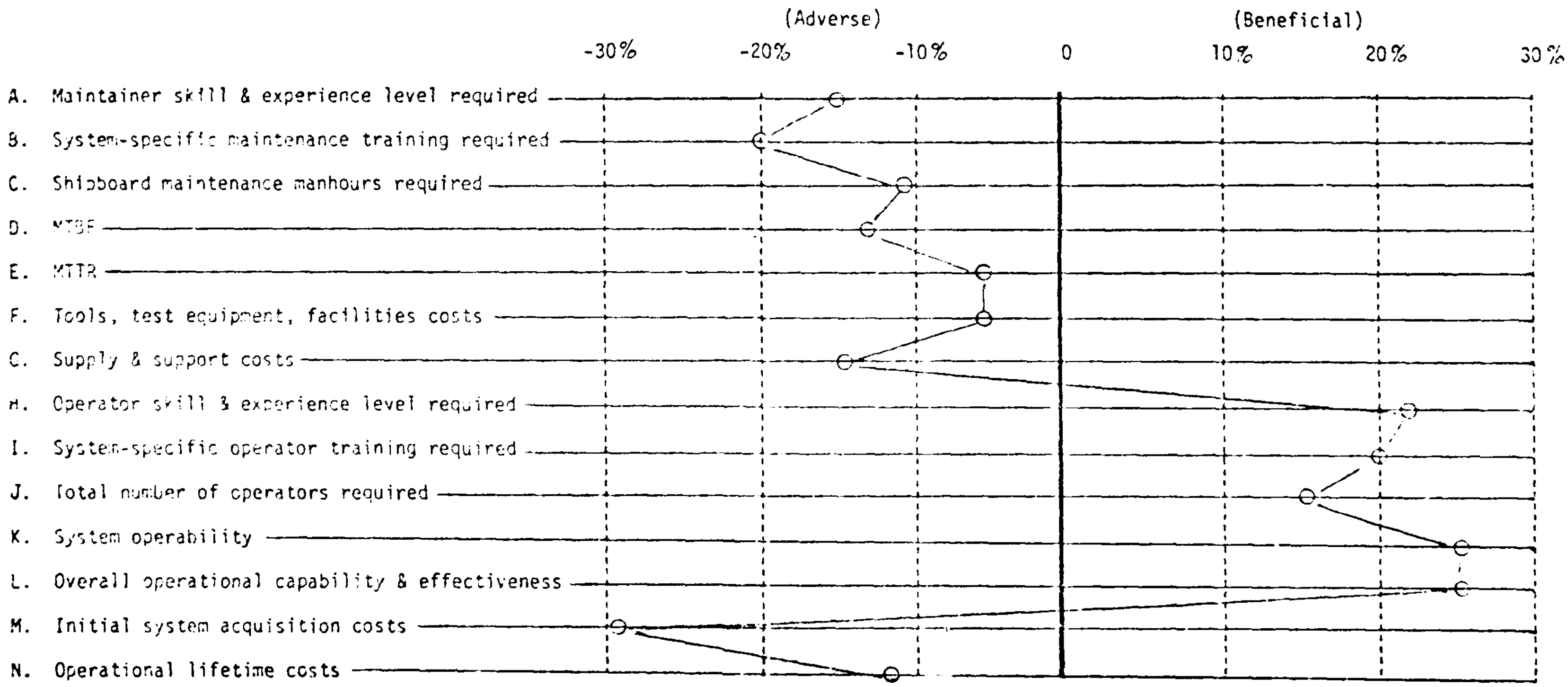
Baseline systems are those that require the correlation, analysis, and interpretation of numerous and complex types of information and rely upon the operator to set up the system to acquire various types of information, interrogate system files, integrate information, interpret it, and make decisions.

PROFILE

The profile for design concept 18 reflects highly beneficial impacts on the number of system operators, their required skill levels and training, as well as system operability and overall effectiveness. However, the profile also reflects substantial negative impacts on initial system acquisition costs and virtually all maintenance-oriented functions.

It is noteworthy that design concept 18 received the lowest technical feasibility rating (.65) of all concepts studied.

18. AUTOMATIC DECISION MAKING



19. AUTOMATED INFORMATION TRANSMISSION AND DISPLAY

DEFINITION

In this design concept, functions requiring runners, phone talkers, plotters, etc., are reduced in number through system features that automatically transfer information from one station to another and automatically format it for display.

BASELINE

The baseline refers to shipboard information transmission and display functions which are accomplished in a traditional, nonautomated fashion using phone talkers, runners, plotters, status board keepers, etc.

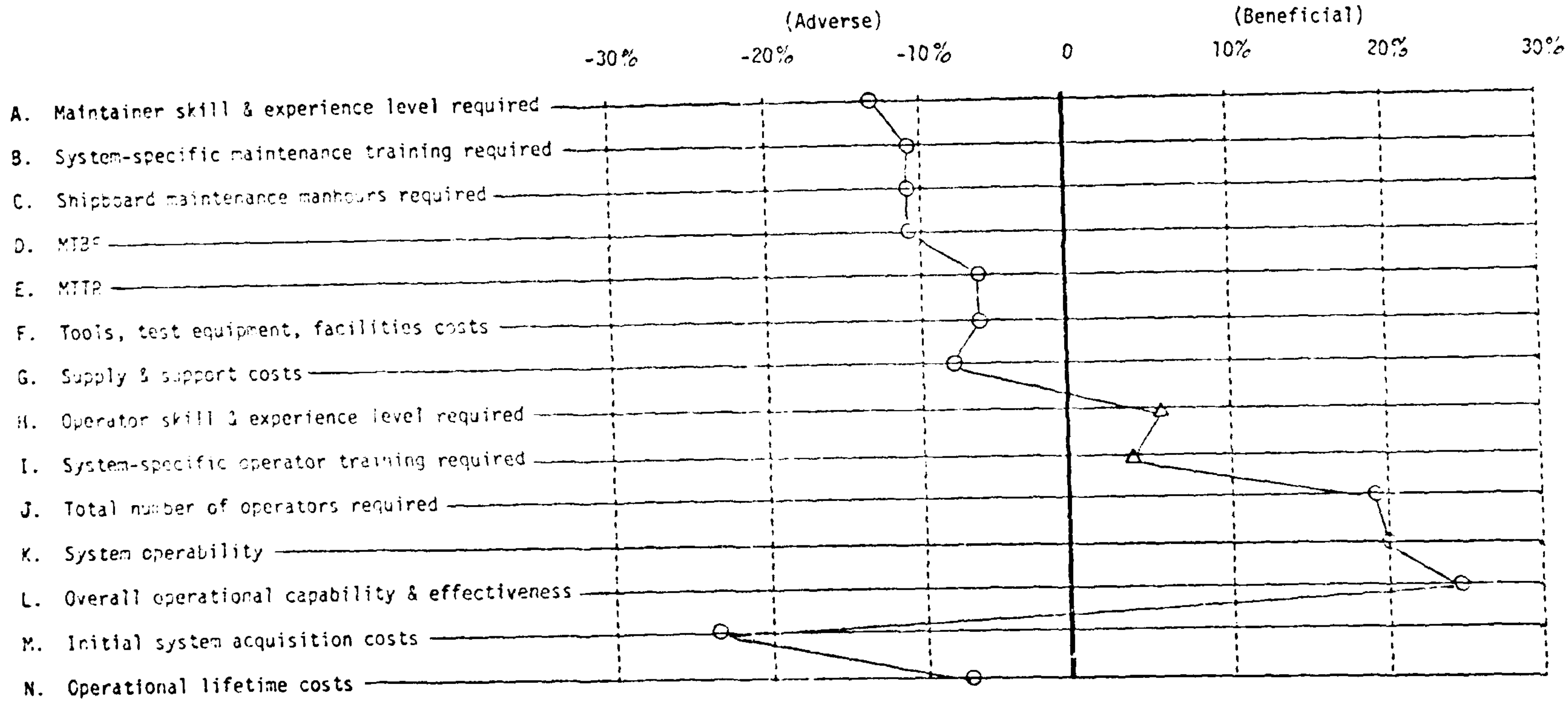
PROFILE

The profile of design concept 19 shows a very positive impact on the number of operational personnel required and on system operability and overall effectiveness. There was considerable disagreement concerning its impact on operator skill level and training, some feeling that the employment of automated transmission and display features increases required skill levels and training, though the majority felt that it would decrease them. This may be a system-specific consideration.

As with some other design concepts that are viewed as having very beneficial effects on operator personnel, design concept 19 was considered to have a negative impact on initial acquisition costs and on most system maintenance criteria.

Design concept 19 was rated average (.80) in technical feasibility.

19. AUTOMATIC INFORMATION TRANSMIT & DISPLAY



Δ - Substantial disagreement on impact

20. BUILT-IN TRAINING CAPABILITY

DEFINITION

In this design concept computer-based systems are provided with additional software and possibly some hardware (a modest instructor terminal in some cases) to perform shipboard training. The training subsystem should reflect a detailed analysis of onboard training requirements and provide additional system features to facilitate effective onboard training.

Trainees operate the system in a training mode during noncritical operating periods at sea, and when in port.

BASELINE

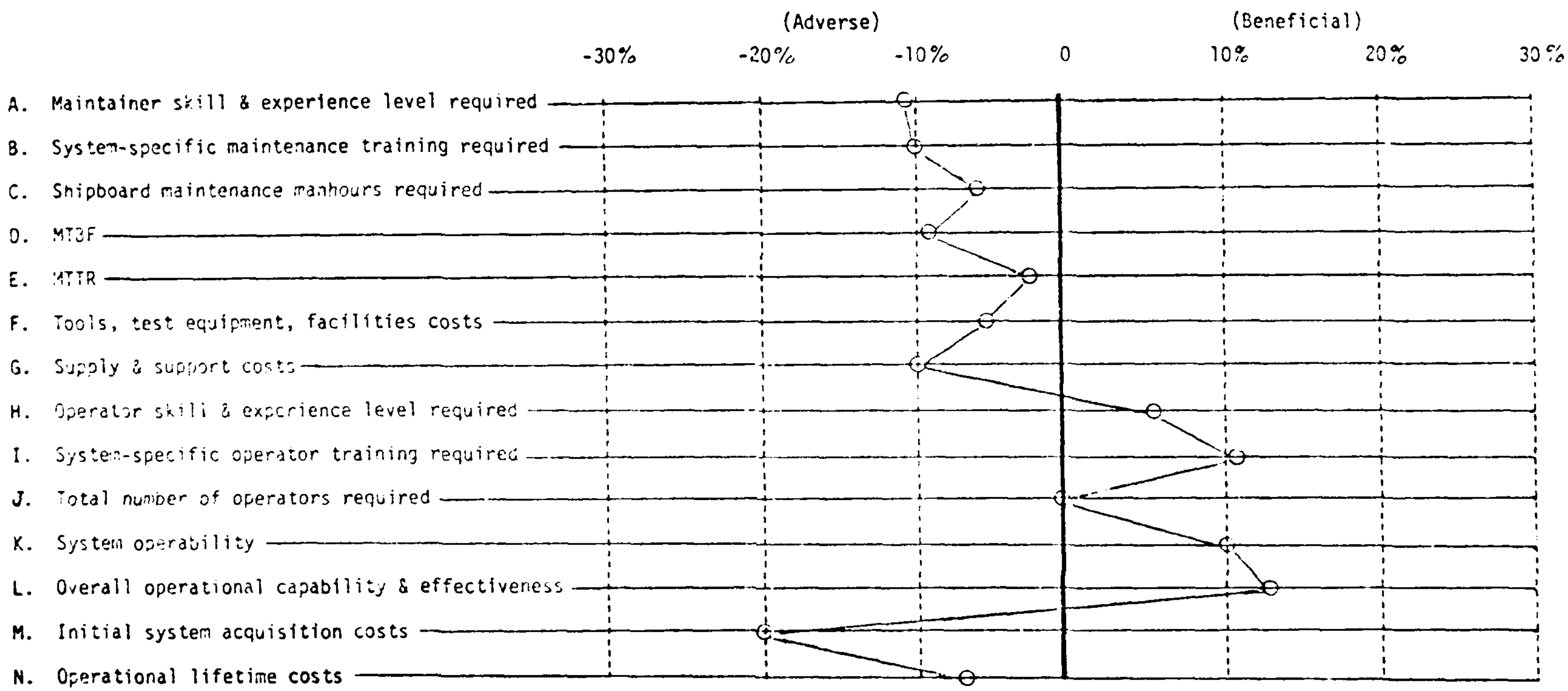
Baseline systems are those which are built to achieve operational goals only; no provisions for training are designed into them. It is expected that *formal training* will be accomplished primarily at shore-based facilities, and that required shipboard training will be achieved on the job or by "looking over the shoulders" of experienced operators.

PROFILE

The profile of design concept 20 shows significant benefits with respect to operator training, system operability, and overall system effectiveness. As with other design features benefiting operators, this comes at a cost to initial acquisition and to the shipboard maintenance function.

The technical feasibility of this concept was judged to be slightly below average (.76).

20. BUILT-IN TRAINING CAPABILITY



21. COMBINED OPERATOR/MAINTAINER FUNCTIONS

DEFINITION

In this concept, equipment is both operated and maintained by the same personnel. While combined operator/maintainer functions is not a design feature per se, as a concept it may have an impact on how the system must be designed in order to cope with, or take advantage of, combined operator/maintainer personnel (depending on your point of view).

BASELINE

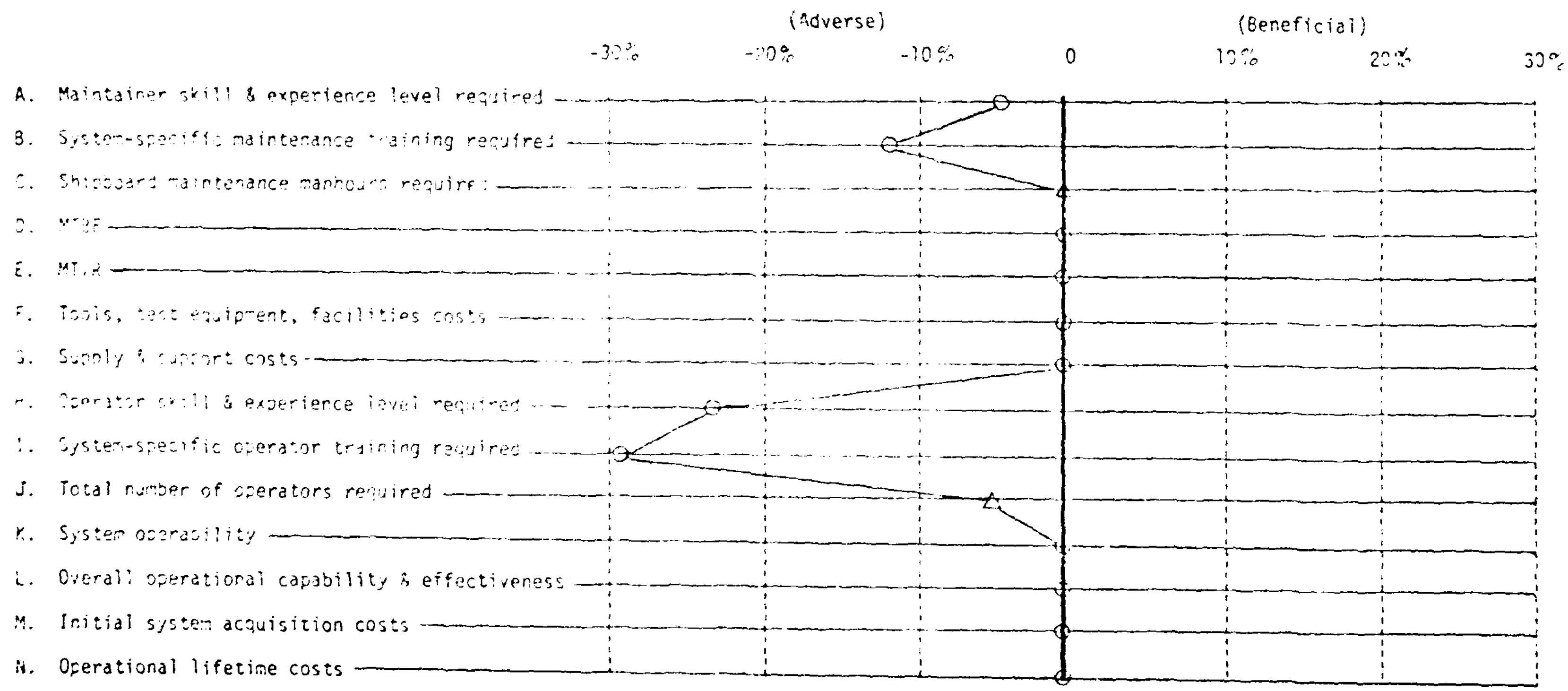
Commonly, two separate categories of personnel have been used to operate and maintain most electronic systems.

PROFILE

The profile of this concept shows that it was generally viewed as having a strong adverse impact on operator training requirements and skill levels required. This is interpreted to mean that operators would require substantially more training than they presently do if they were to be given responsibility for maintaining their systems as well as operating them. There is a smaller but still substantial negative impact on the training of maintenance personnel as well. However, it is evident that this concept was viewed as requiring a greater training increment to make maintainers out of operators than for making operators out of maintainers.

The technical feasibility of this concept was rated as relatively low (.71).

21. COMBINED OPERATOR/MAINTAINER FUNCTIONS



Δ - Substantial disagreement on impact

SECTION 2

INTERACTION OF DESIGN CONCEPT IMPACTS ON DIFFERENT SYSTEM DESIGN CRITERIA

ADDRESSING QUESTION 2

> How do the manpower and training considerations interact with other criteria used in evaluating system design?

The information presented in this section is complementary to that presented in Section 1. First, all the evaluative criteria are defined, and then a profile is presented for each criterion showing how all 21 design concepts impact on it. Figure 5 shows where this information may be used in the overall design process.

EVALUATIVE CRITERIA

> What evaluative criteria are we talking about?

The evaluative criteria, and the page numbers on which their definitions will be found, are as follows:

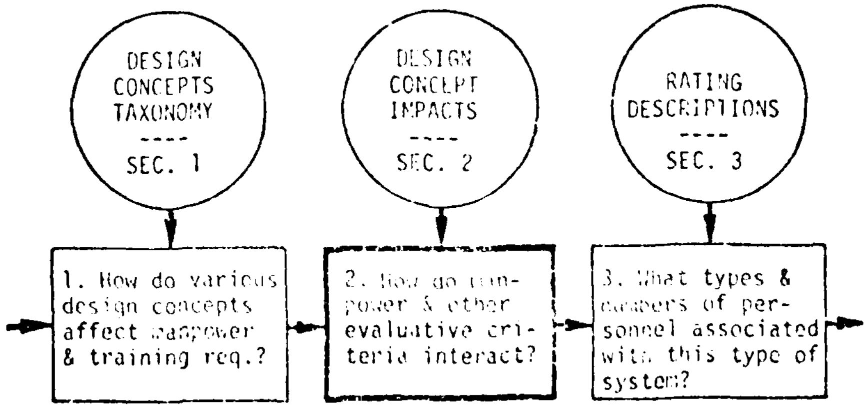


Figure 5. Addressing Question 2.

- Maintainer skill and experience level required 2-4
- System-specific maintenance training required 2-6
- Shipboard maintenance man-hours required 2-8
- Mean time between failures (MTBF) 2-10
- Mean time to repair (MTTR) 2-12
- Tools, test equipment, and facilities costs 2-14
- Supply and support costs 2-16
- Operator skill and experience level required 2-18
- System-specific operator training required 2-20
- Total number of operators required 2-22
- System operability 2-24
- Overall operational capability and effectiveness 2-26
- Initial system acquisition costs 2-28
- Operational lifetime costs 2-30

The designer may find the profiles in this section particularly helpful in identifying design concept alternatives that are more effective or less costly in some respect than his initial choice. Those design concepts that have particularly pronounced (or very little) effects on a selected evaluative criterion can quickly be spotted.

For example, if he is concerned with the amount of system-specific maintenance required, inspection of pages 2-6 and 2-7 shows that such concepts as remote repair, throwaway maintenance, troubleshooting logic aids, and automatic fault localization all impact this criterion quite favorably. The same profile also shows, however, that such concepts as embedded computers, automatic decision making, automatic information transmission, and built-in training capability impact this criterion quite unfavorably.

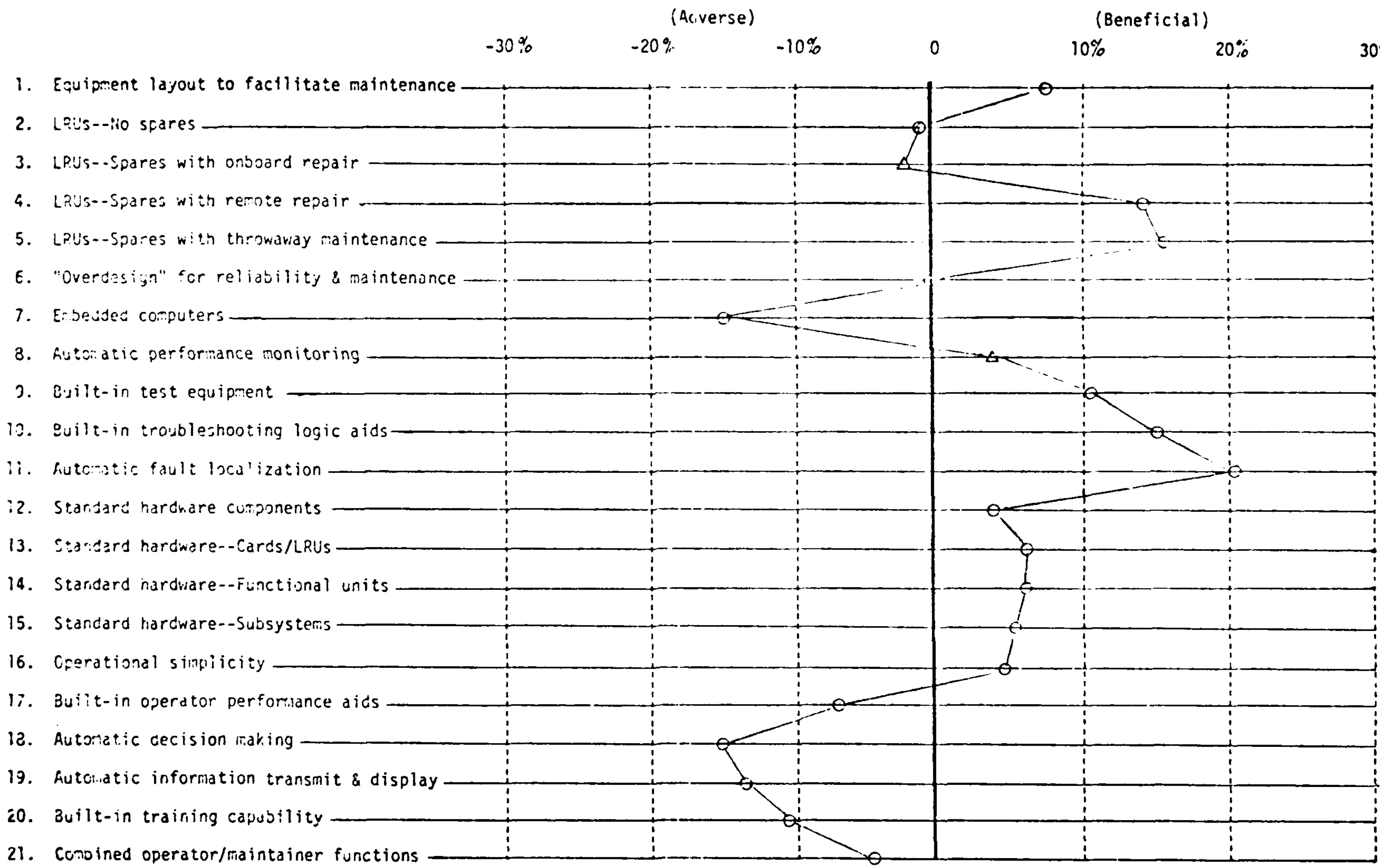
How the data comprising these profiles can be conveniently used in design tradeoff studies is explained in Section 5.

PROFILES OF SYSTEM DESIGN CRITERIA

A. GENERAL MAINTENANCE SKILL AND EXPERIENCE LEVEL REQUIRED

The judges compared the general skill and/or experience level of personnel required to effectively perform all required shipboard maintenance on the baseline system versus a system incorporating the design concept. Their ratings reflect the percentage change, upward or downward, of the number of people beyond their first enlistment required to fully maintain the system.

A. MAINTAINER SKILL & EXPERIENCE LEVEL REQUIRED

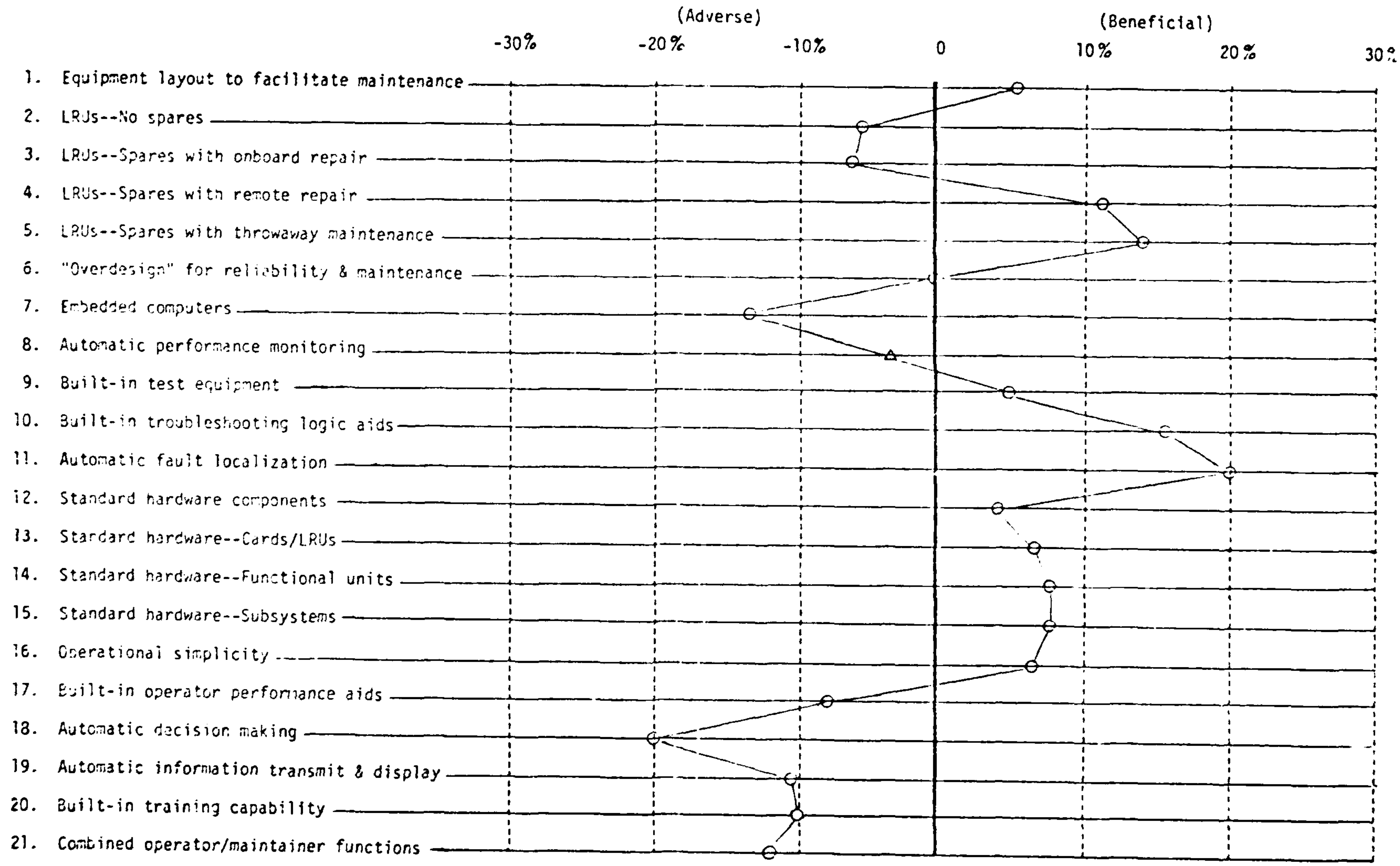


Δ - Substantial disagreement on impact

B. SYSTEM-SPECIFIC MAINTENANCE TRAINING REQUIREMENTS

The judges considered the necessary duration of all system-specific maintenance training, such as that included in C-school and other special courses, in estimating the increased or decreased training time requirements for developing a qualified shipboard maintainer of a system employing the design concept versus the baseline approach. If it was felt that prerequisite NECs would be required to be eligible for maintenance training on either the baseline or the design concept system, the training time required to achieve those NECs was considered as well.

B. SYSTEM-SPECIFIC MAINTENANCE TRAINING REQUIRED

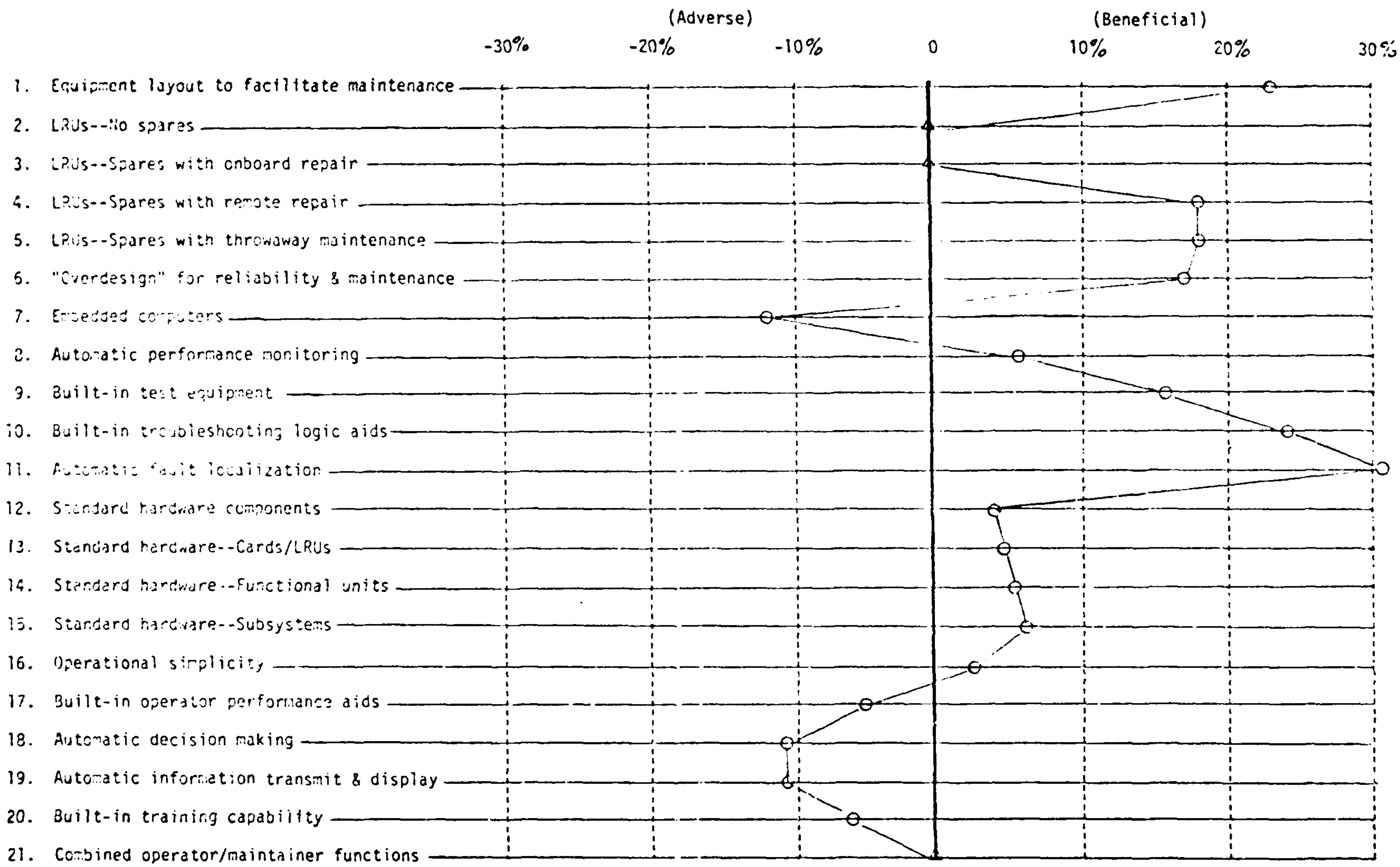


Δ - Substantial disagreement on impact

C. TOTAL NUMBER OF SHIPBOARD MAINTENANCE MAN-HOURS REQUIRED

This criterion reflected the increase or decrease, in comparing the baseline and design concept systems, that would occur solely in the man-hours of maintenance required onboard ship for a given system. The total maintenance workload including both preventive and corrective maintenance was considered.

C. SHIPBOARD MAINTENANCE MAN-HOURS REQUIRED

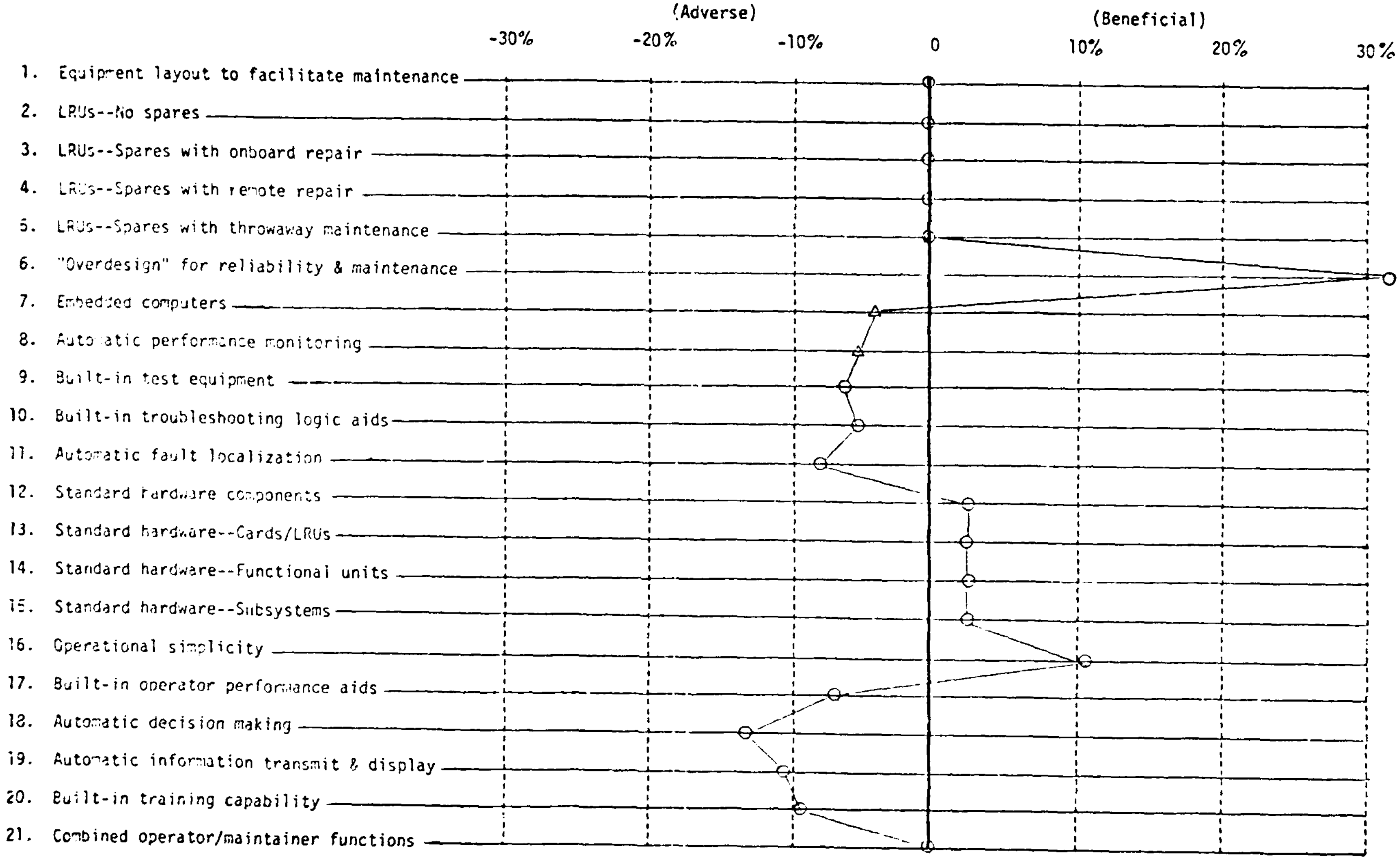


Δ - Substantial disagreement on impact

D. SYSTEM RELIABILITY--MTBF (MEAN TIME BETWEEN FAILURES)

This criterion focused on MTBF as the classic measure of system reliability. The judges considered the percentage increase or decrease in this measure of reliability that might be expected in going from the baseline to the design concept for a given system.

D. MTBF

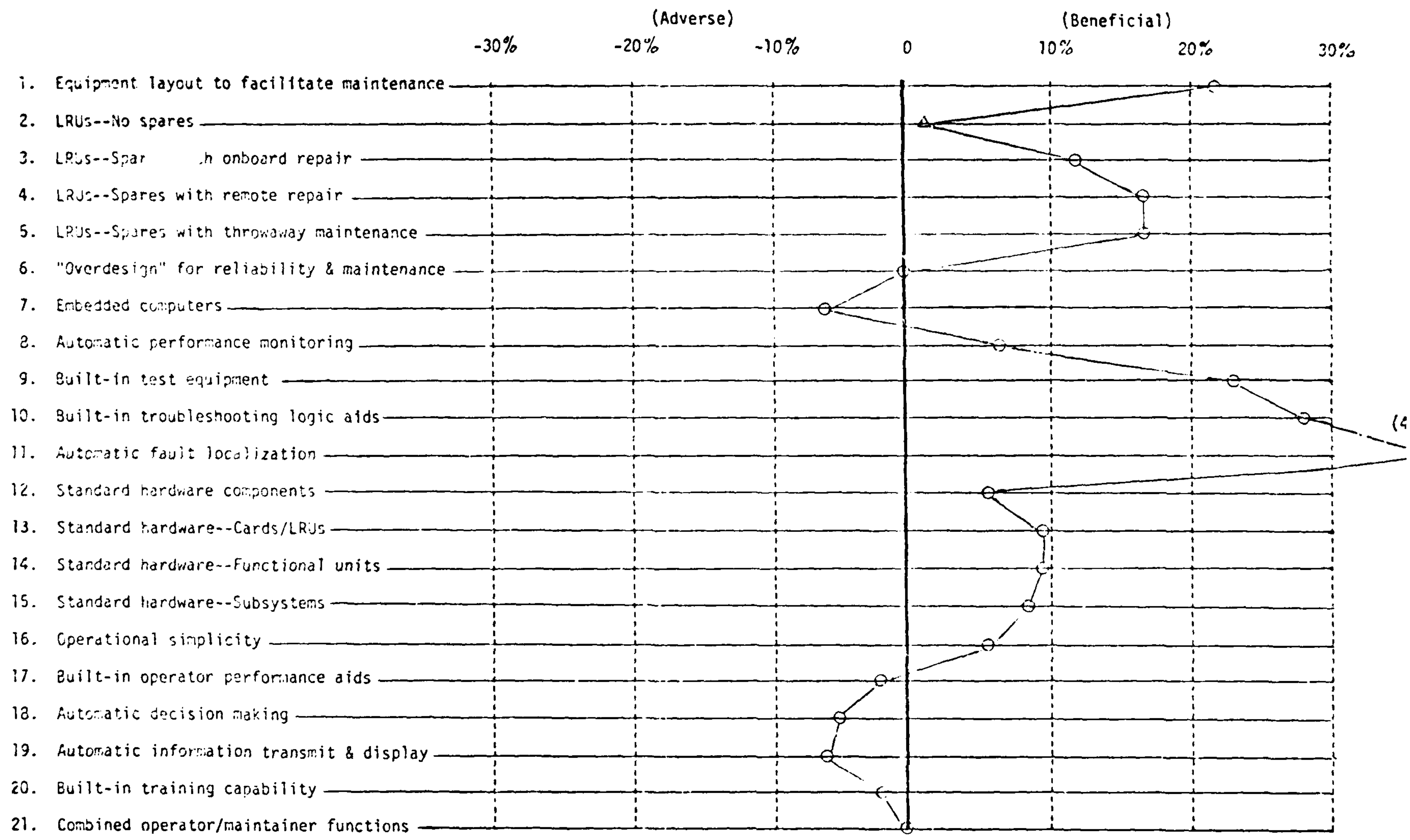


Δ - Substantial disagreement on impact

E. SYSTEM MAINTAINABILITY--MTTR (MEAN TIME TO REPAIR)

This criterion focused on one of the standard measures of maintainability, the average time it takes for a system to be repaired. This includes the time to isolate the fault, the time to repair the fault (this may be a remove-replace under certain design concepts), and the time to verify that the fault has been corrected. Supply time was <u>not</u> included in this dimension.

E. MTTR

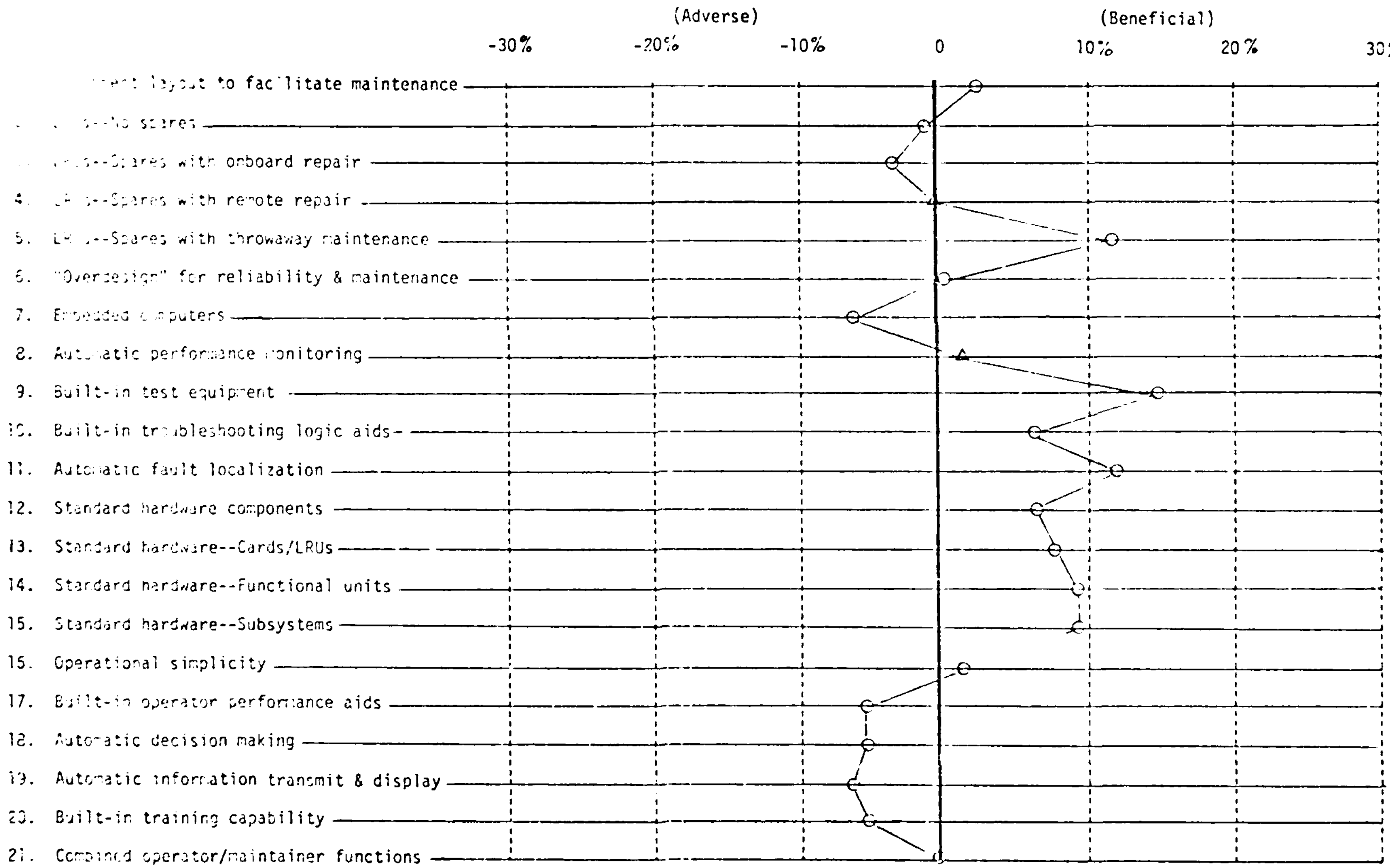


Δ - Substantial disagreement on impact

F. TOOLS, TEST EQUIPMENT, AND FACILITIES COSTS

This criterion was defined as an aggregate estimate of all the costs involved in providing adequate separate tools, test equipment, and facilities to maintain a system; built-in test equipment (BITE) costs were not included in this definition. The judges considered all levels of maintenance (shipboard, tender, depot, and factory) in estimating the percent improvement (reduction in costs) or degradation (increase in costs) in going *from* the baseline to the design concept.

F. TOOLS, TEST EQUIPMENT, FACILITIES COSTS

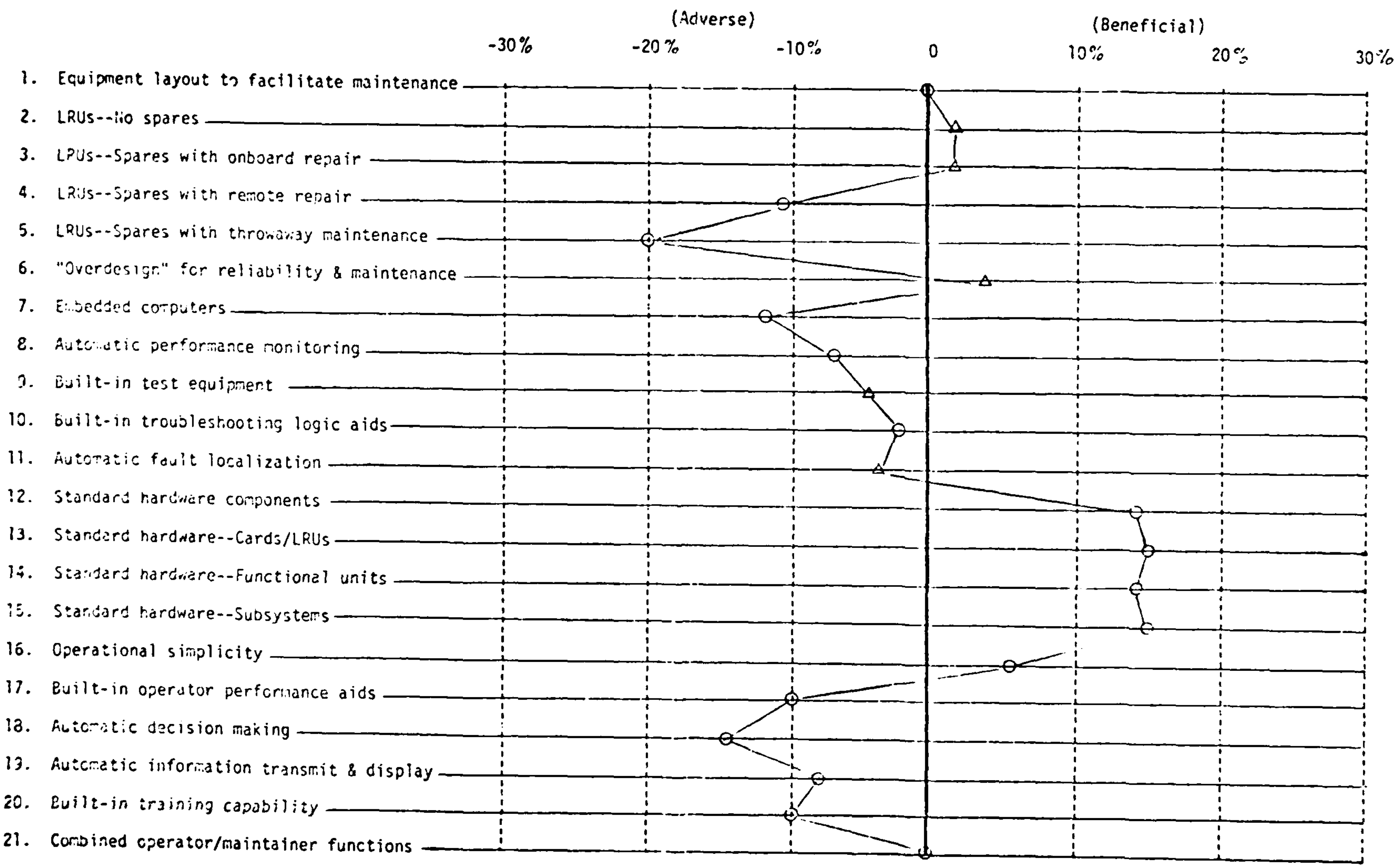


Δ - Substantial disagreement on impact

G. SUPPLY AND SUPPORT COSTS

For this dimension the judges considered the costs of acquisition, cataloging, packaging, preservation, receipt, storage, transfer, issue, and disposal of spares and repair parts associated with a system that is designed according to the baseline versus one that is designed according to a design concept.

G. SUPPLY & SUPPORT COSTS

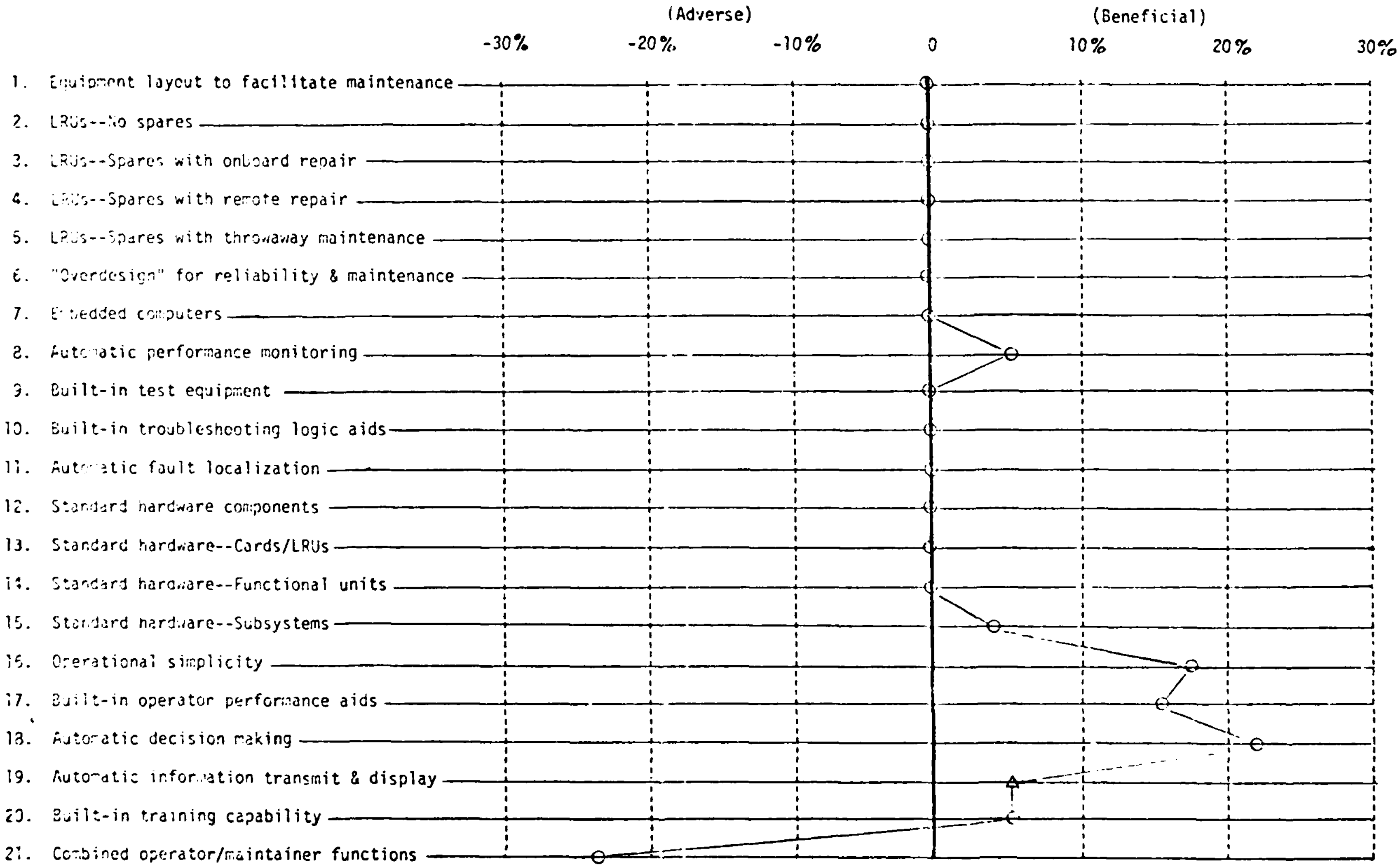


Δ - Substantial disagreement on impact

H. REQUIRED GENERAL SKILL AND EXPERIENCE LEVEL OF OPERATORS

The judges considered the increase or decrease, in going from the baseline to the design concept, in the average, general skill and/or experience level of personnel required to operate the system. They estimated the percentage change, upward or downward, in the number of people beyond their first enlistment required to ensure a high degree of system operational effectiveness. They considered requirements for team coordination as well as individual skill levels.

H. OPERATOR SKILL & EXPERIENCE LEVEL REQUIRED

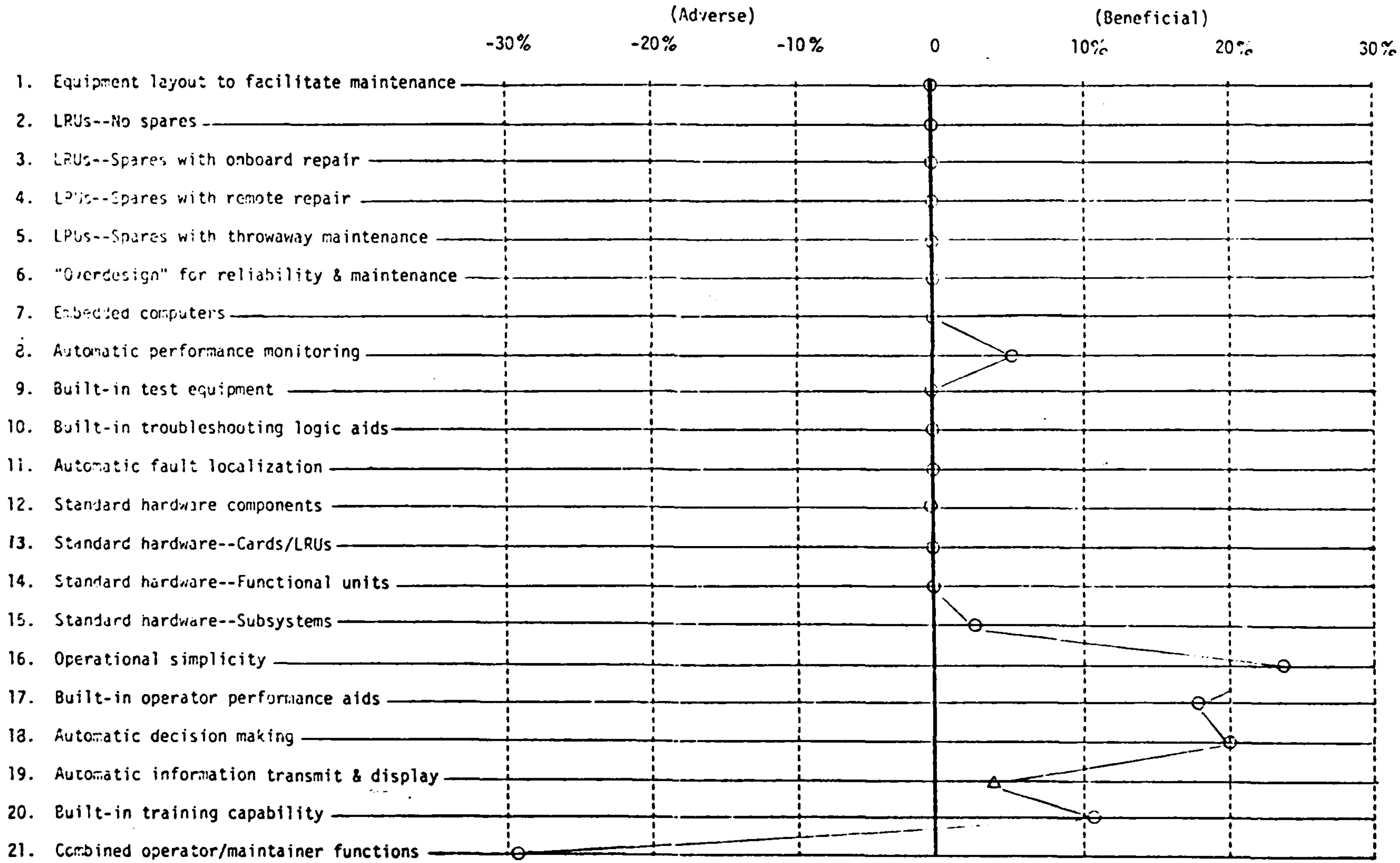


Δ - Substantial disagreement on impact

I. SYSTEM-SPECIFIC OPERATOR TRAINING REQUIREMENTS

This criterion concerned the amount of initial training time required to develop qualified operators for a system and how that time might be increased or decreased as a result of going from the baseline to the design concept. The judges considered both operator training as typically given in that portion of A-school training that focuses on particular systems, as well as any special operational courses that might be required. They also considered the amount of on-the-job training (OJT) that might be necessary aboard ship before an operator becomes fully qualified.

I. SYSTEM-SPECIFIC OPERATOR TRAINING REQUIRED

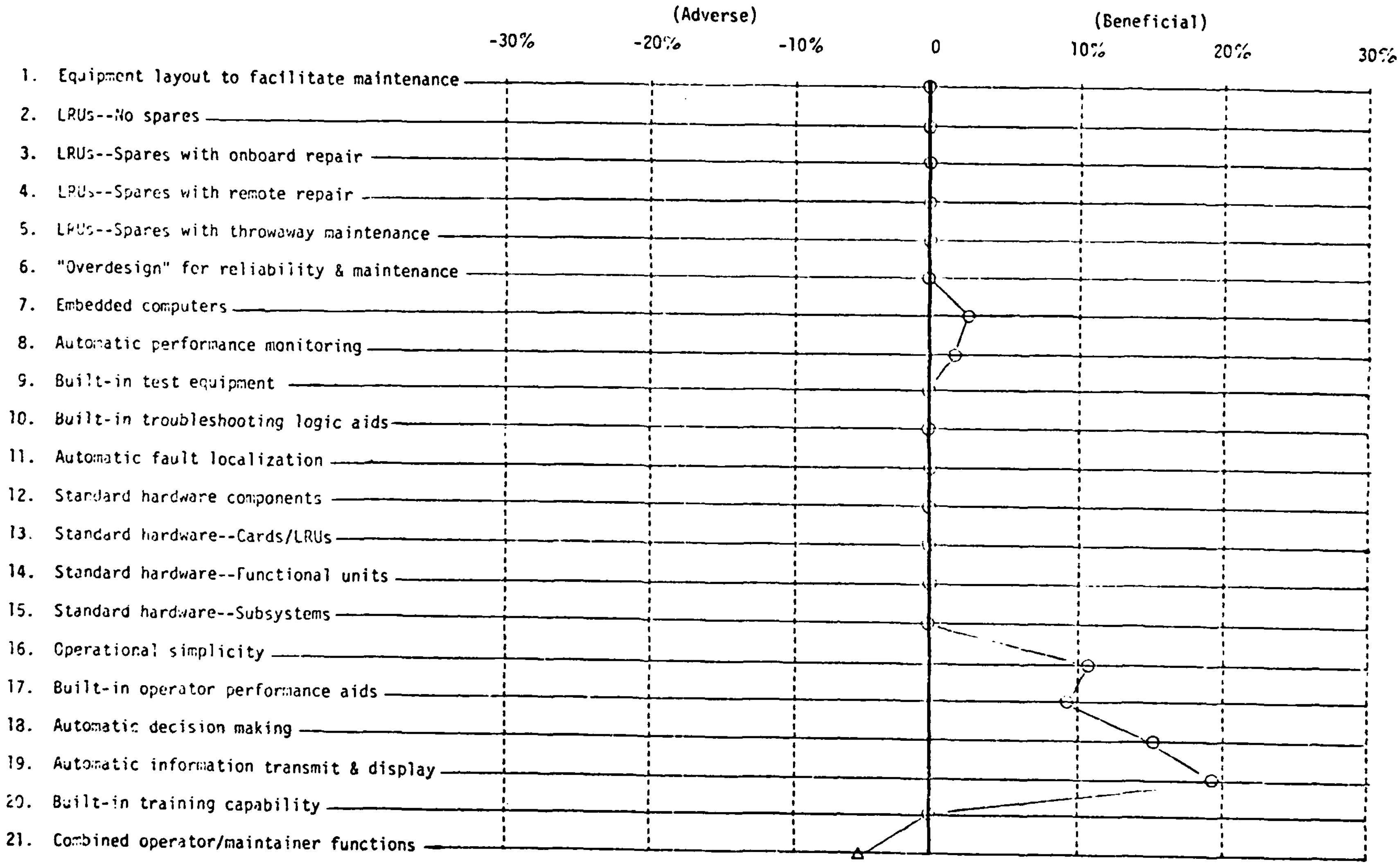


Δ - Substantial disagreement on impact

J. TOTAL NUMBER OF OPERATORS REQUIRED

This criterion was defined as the total number of operators that would be required to man the system under the most demanding operational circumstances. In estimating the required number of operators for a baseline versus a design concept, the judges considered both the number of operator stations and the total operator task load associated with the use of each concept.

J. TOTAL NUMBER OF OPERATORS REQUIRED

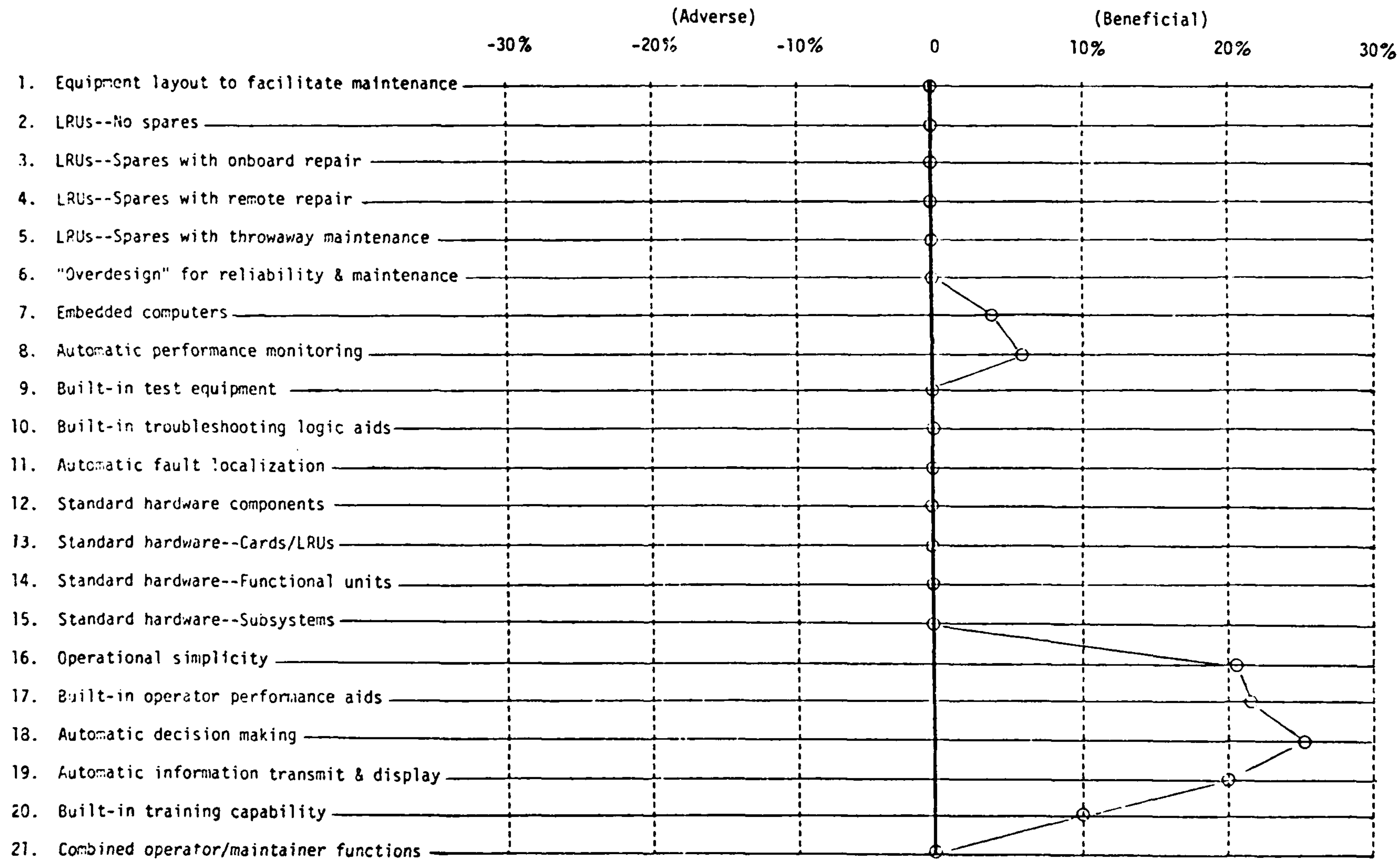


Δ - Substantial disagreement on impact

K. SYSTEM OPERABILITY

This criterion focused on those aspects of the system design that relate to easy or difficult operation, operator error rate, and operational reaction time. Taking into account such parameters, the judges considered both the number of operator stations and the total operator task load associated with the use of each concept.

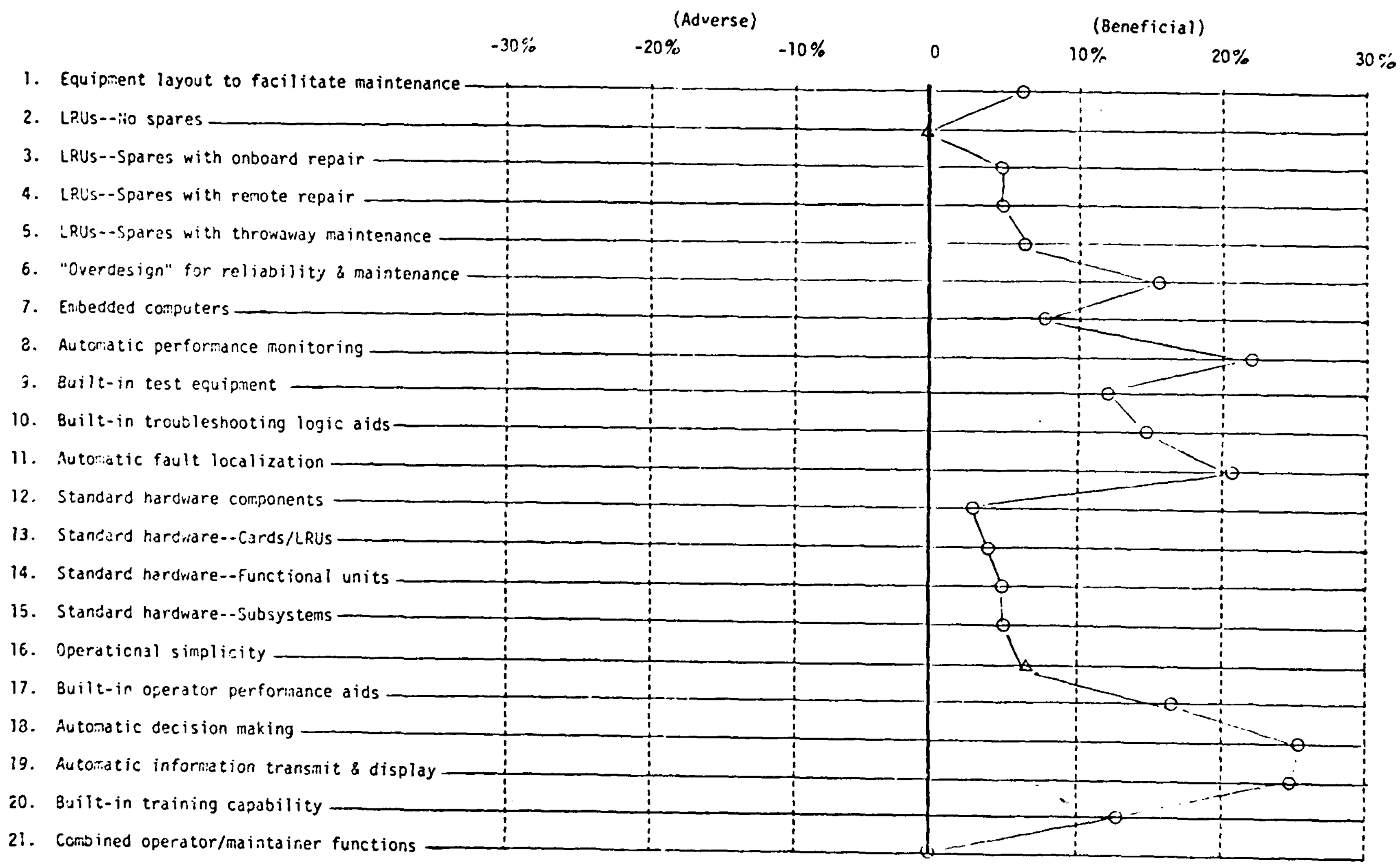
K. SYSTEM OPERABILITY



L. OVERALL OPERATIONAL CAPABILITY AND EFFECTIVENESS

This criterion concerned the capability of a system employing the design concept compared to a baseline system for fully meeting all operational requirements. The judges considered the likely improvement or degradation of total capability and effectiveness in going from a baseline to a design concept.

L. OVERALL OPERATIONAL CAPABILITY & EFFECTIVENESS



Δ - Substantial disagreement on impact

M. INITIAL SYSTEM ACQUISITION COSTS

Under this criterion, consideration was given to all initial acquisition costs, including design, development, and operational shakedown for both system hardware and software. In addition, because any necessary system trainers are usually considered to be part of initial system acquisition, the cost of such trainers was included in this consideration. The judges estimated the percentage increase or decrease of initial acquisition costs for a system employing the design concept as compared to the baseline system.

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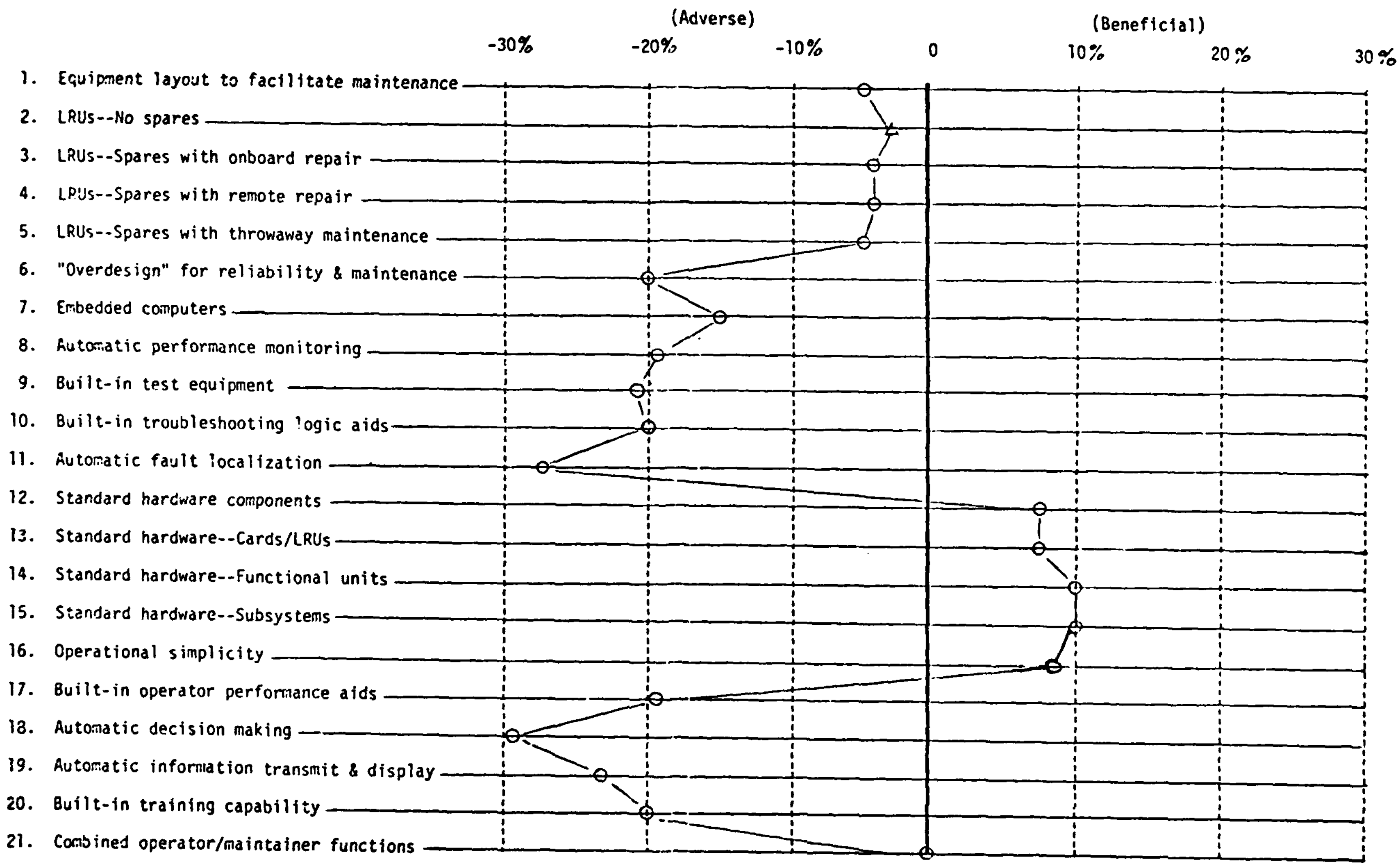
M. INITIAL SYSTEM ACQUISITION COSTS

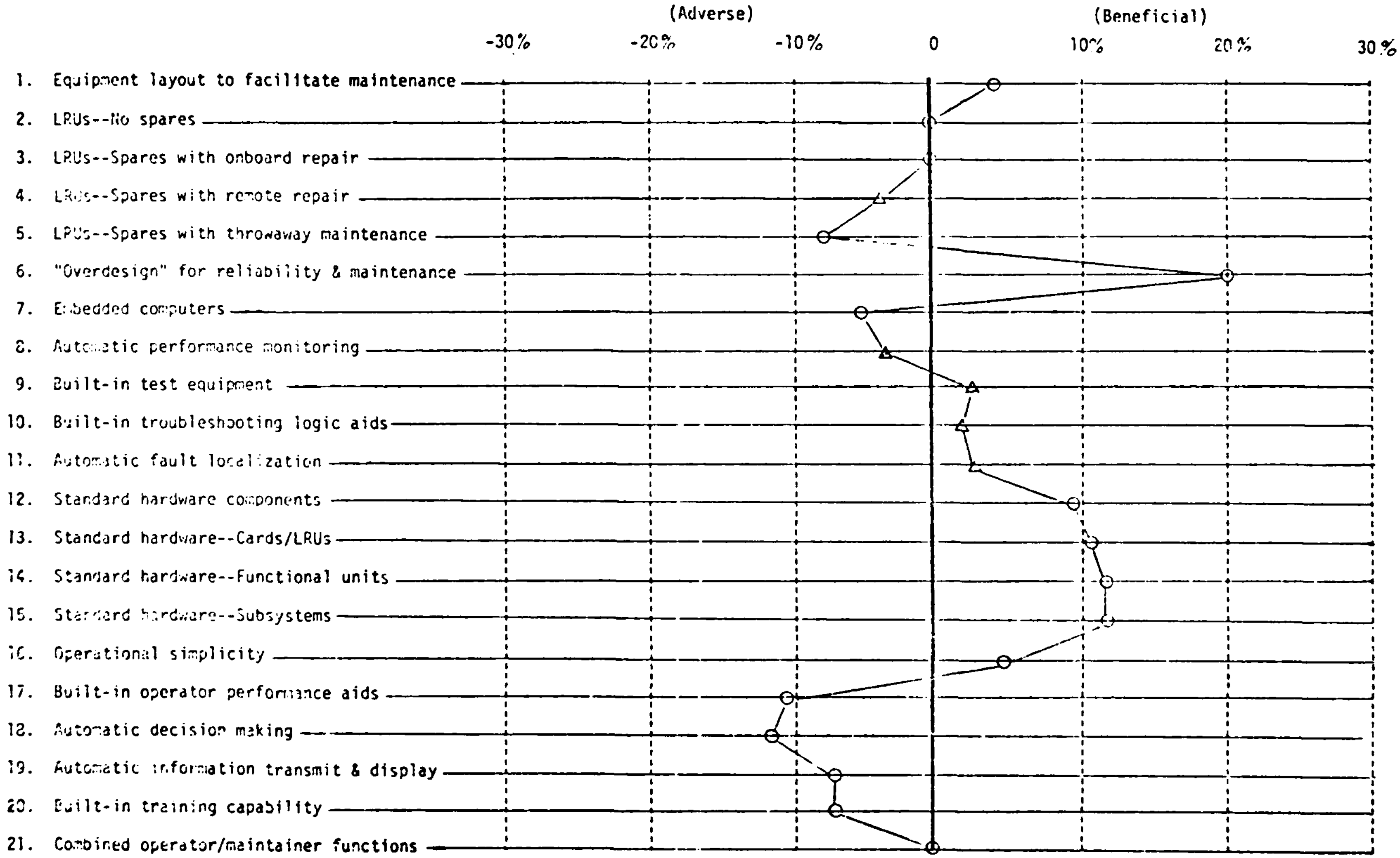


Δ - Substantial disagreement on impact

N. OPERATIONAL LIFETIME COSTS

For this criterion, the percentage increase or decrease that might be expected to result in going from the baseline approach to the design concept for a given system, for all the hardware and software required over a 20-year lifecycle, was considered. This criterion excluded initial acquisition costs and lifecycle personnel costs since the impact of these variables was considered elsewhere.

N. OPERATIONAL LIFETIME COSTS



△ - Substantial disagreement on impact

SECTION 3

TYPES OF TECHNICIANS ASSIGNED TO SURFACE SHIP ELECTRONIC SYSTEMS

ADDRESSING QUESTION 3

What types and numbers of Navy personnel typically operate and maintain this type of system?

Table 2 and the subsequently presented descriptions identify the types of technicians, and their official responsibilities, used for the operation and maintenance of surface ship radar, sonar, communications, fire control, and data processing systems. This information is presented here for the convenience of those who are not already familiar with the Navy's personnel classifications. It will help the designer answer Question 3, as shown in Figure 6.

As noted earlier, some complex computerized systems will generate maintenance tasks that cut across these traditional areas of responsibility. This may have important implications not only for personnel supply (Section 4) but for training support (Section 8).

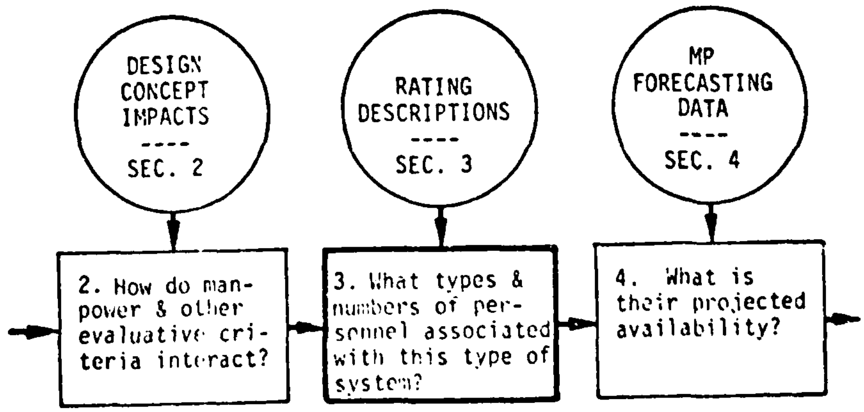


Figure 6. Addressing Question 3.

> The designer should be aware of the numbers and skill levels (pay grades) of personnel authorized to operate and maintain appropriate predecessor systems.

Since a design objective should be, if possible, to reduce the demand on human resources compared to earlier systems, the designer needs information concerning the officially approved manning quotas for the predecessor system that the new system will replace. This information is obtainable in official Ship Manpower Documents which are developed and maintained by OPNAV 111C1 (Ship Manpower Requirements).

TABLE 2
TECHNICIANS RESPONSIBLE FOR SELECTED SURFACE SHIP ELECTRONIC SYSTEMS

	TYPE OF SYSTEM					
TYPE OF PERSONNEL	Data Systems	Communications	Fire Control (Missile)	Navigation	Radar	Sonar
Data Systems Technician (DS)	M					
Electronics Technician [ET(N)]		M		M		
Electronics Technician [ET(R)]				M	M	
Fire Control Technician (FTM)			O/M		M	
Radioman (RM)		O/M				
Sonar Technician (STG)						O/M

M = Maintenance responsibility

O = Operational responsibility

OFFICIAL RESPONSIBILITIES OF SELECTED TECHNICIANS (SOURCE: NAVPERS 18068D)

Data Systems Technicians (DS) perform organizational and intermediate maintenance on electronic digital data systems and equipment; inspect, test, calibrate, and repair computers, external storage devices, digitial interface equipment, digital display equipment, data link terminal equipment, peripheral equipment, and related equipment; perform preventive maintenance on test equipment; and prepare and use programmed test routines.

Electronics Technicians, Communications (ETN) perform organizational and intermediate level maintenance on communication equipment, electronic cryptographic equipment, and aids to navigation.

Electronics Technicians, Radar (ETR) perform organizational and intermediate level maintenance on electronic surface and air detection and tracking equipment, electronic recognition and identification equipment, and aids to navigation.

Fire Control Technicians, Surface Missile Fire Control (FTM) perform organizational and intermediate level maintenance on missile fire control systems (including weapons direction systems and search radars), missiles, telemetry equipment, and associated support equipment; operate, test, and repair shipboard missile fire control systems (including weapons direction systems and search radars), missiles, telemetry equipment, and associated support equipment.

Radiomen (RM) transmit, receive, and process all forms of telecommunications through various transmission media, applying the basic principles of reliability, security, and speed in accordance with appropriate doctrinal and procedural publications; operate, monitor, and control telecommunications transmission, reception, terminal, and processing equipment; advise on capabilities, limitations, and condition of equipment; employ knowledge of electronic and operational system theory in applying diagnostic and restoral techniques; perform assigned mission organizational level maintenance on telecommunications equipment and systems.

Sonar Technicians, Surface (STG) operate (manipulate, control, evaluate, and interpret data) surface sonar and oceanographic equipment,

surface ship underwater fire control equipment, and associated equipment for the solution of antisubmarine warfare problems; perform organizational and intermediate maintenance on surface sonar and allied equipment.

SECTION 4

PROJECTED SUPPLY OF TECHNICAL RATINGS AT DIFFERENT EXPERIENCE LEVELS

ADDRESSING QUESTION 4

What is the projected availability of the required types of personnel? Are they likely to be in sufficient supply during the time frame of interest?

Figure 7 shows where this question is addressed in the conceptual design process. The data required to answer it have been excerpted from a more general report on Navy manpower availability prepared by NPRDC.*

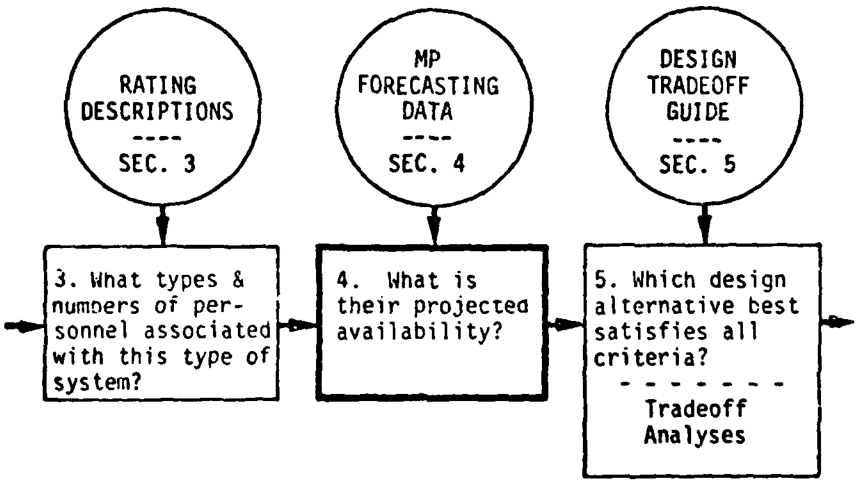


Figure 7. Addressing Question 4.

*Koehler, E. A. Manpower availability--Navy enlisted projections--FY78-FY84 (NPRDC SR 79-11). San Diego: Navy Personnel Research and Development Center, 1979.

These data, presented on the following pages, provide an explicit answer to Question 4. Graphs are presented for DS, ET, FTM, RM, and STG personnel (Figures 8-13) showing the following:

1. Number of personnel available at the end of fiscal years 1978-84.

2. Number of personnel needed to meet CNO estimated requirements.

3. The difference (surplus or shortfall) between available and required numbers at each level of experience (pay grade).

For example, if the designer anticipates that his system will be maintained by electronic technicians (ETs), inspection of pages 4-5 and 4-6 reveals that although there will be a surplus of 3rd class ETs (pay grade E-4), a severe shortage of 2nd class (E-5) and 1st class (E-6) ETs is forecast. The clear implication of these data is that the system should be designed, to the fullest extent possible, to the skill levels possessed by 3rd class ETs. To determine what these skill levels are, he will need to refer to Section 6.

CURRENT SHORTAGES ARE EXPECTED TO CONTINUE

> There is a projected shortfall of experienced technicians of virtually every type associated with surface ship electronic systems. These shortages are expected to continue.

The persistent shortages in experienced personnel reflected in these graphs are expected to continue beyond 1984. Thus, the designer should view any currently projected shortfall as one that is likely to continue even though a system now in design may not be operational until well beyond 1984.

PROJECTED PERSONNEL SUPPLY

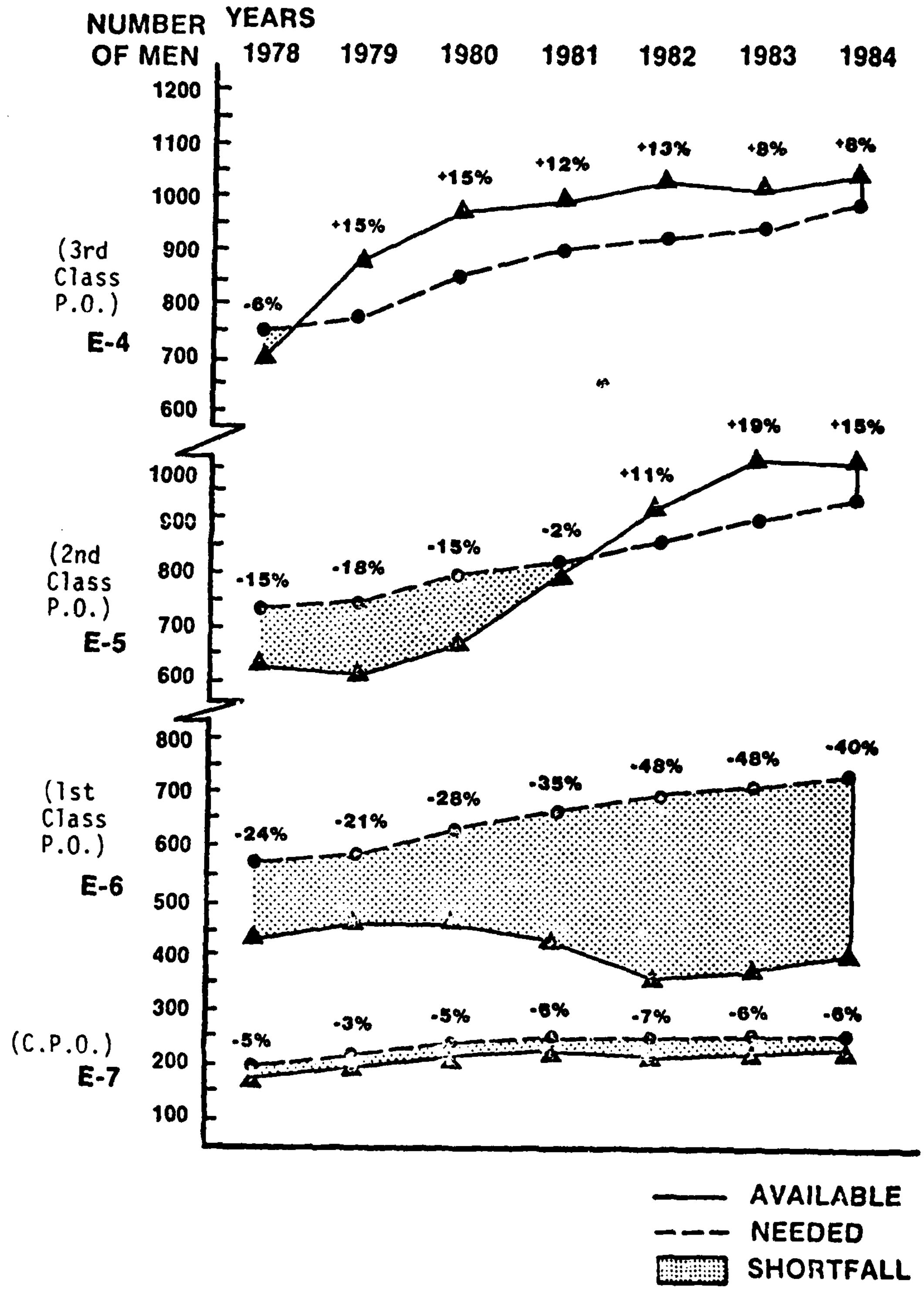


Figure 8. DS (Data Systems Technician).

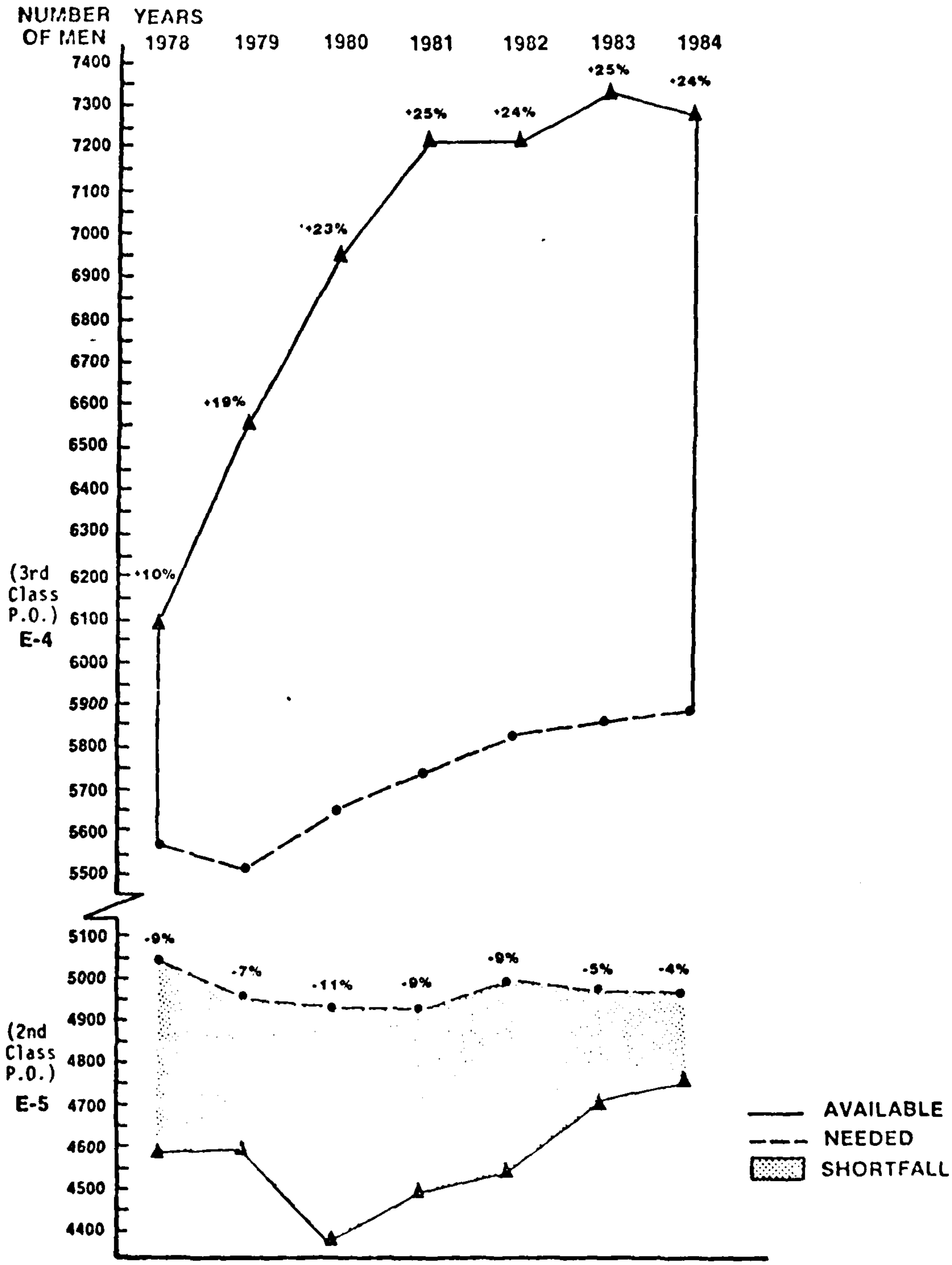


Figure 9. ET (Electronics Technician).

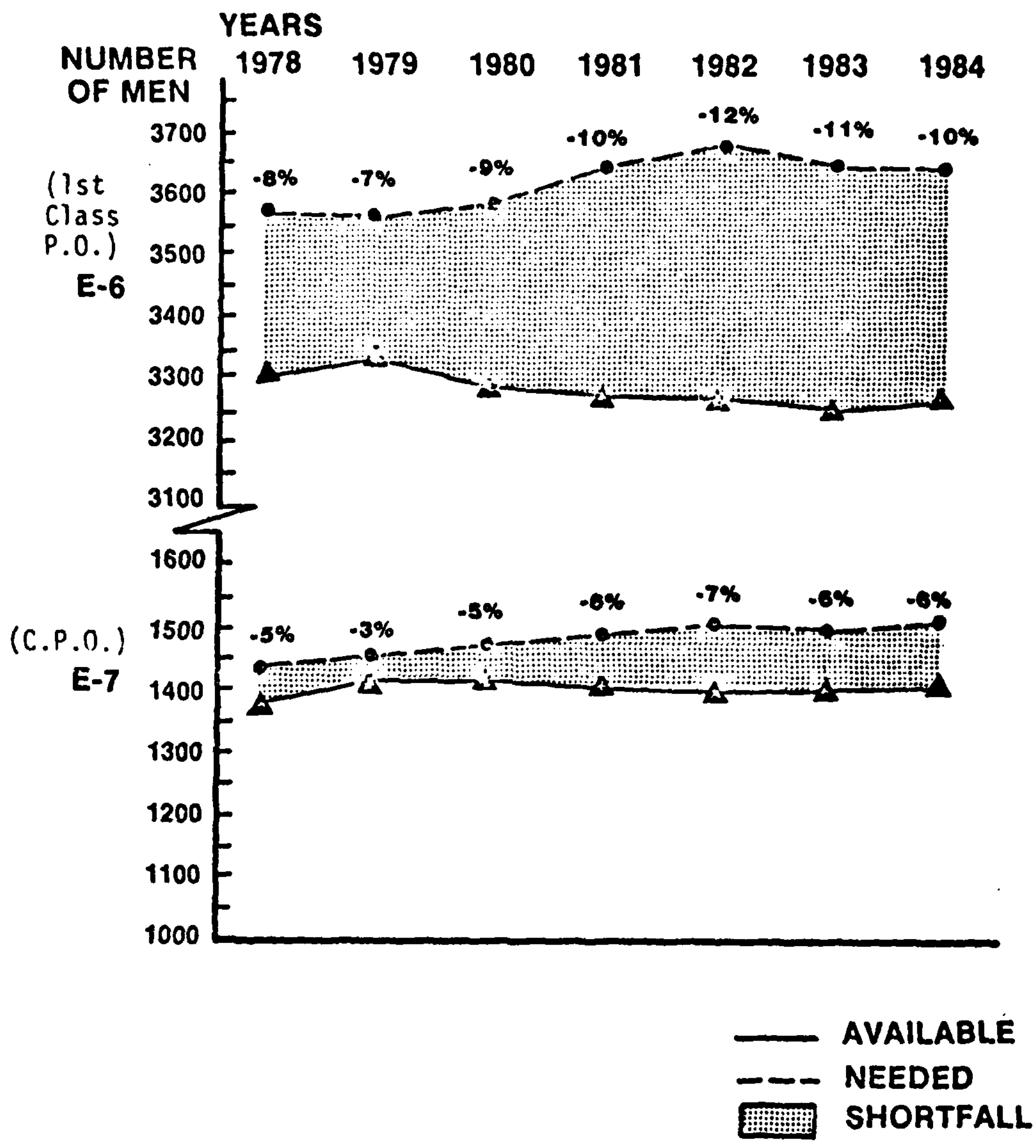


Figure 10. ET (Electronics Technician).

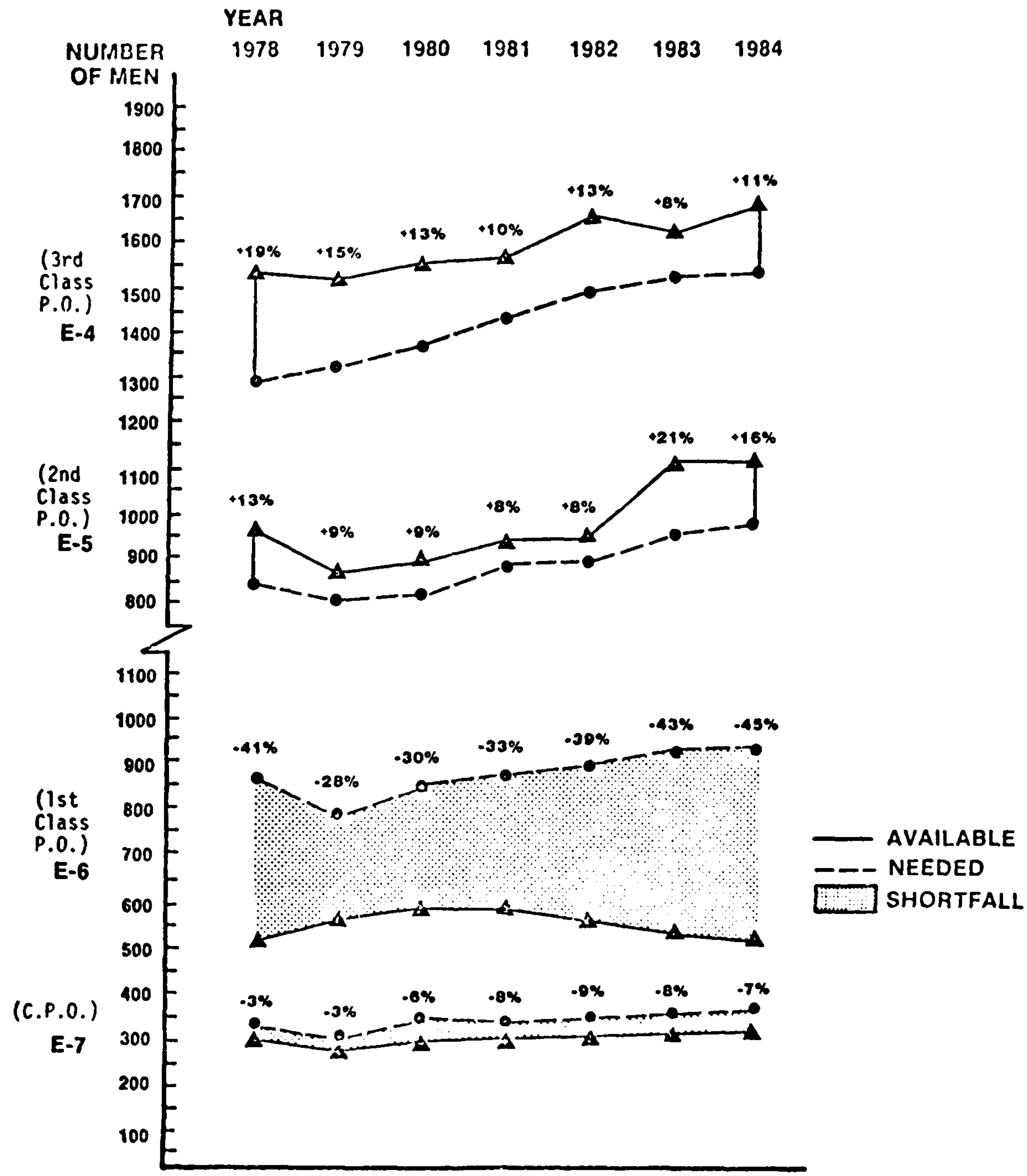


Figure 11. FTM (Fire Control Technician, Surface Missile).

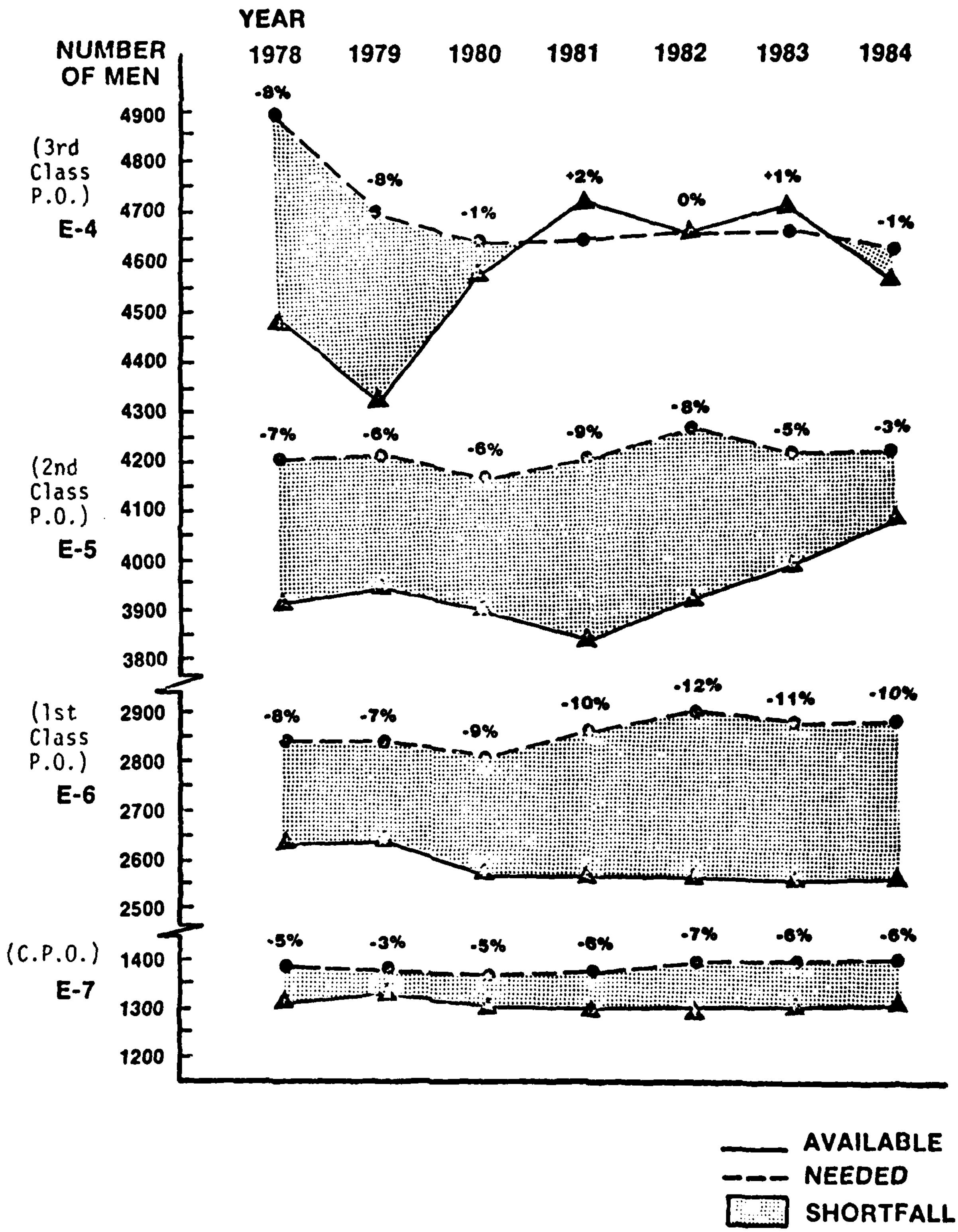


Figure 12. RM (Radioman).

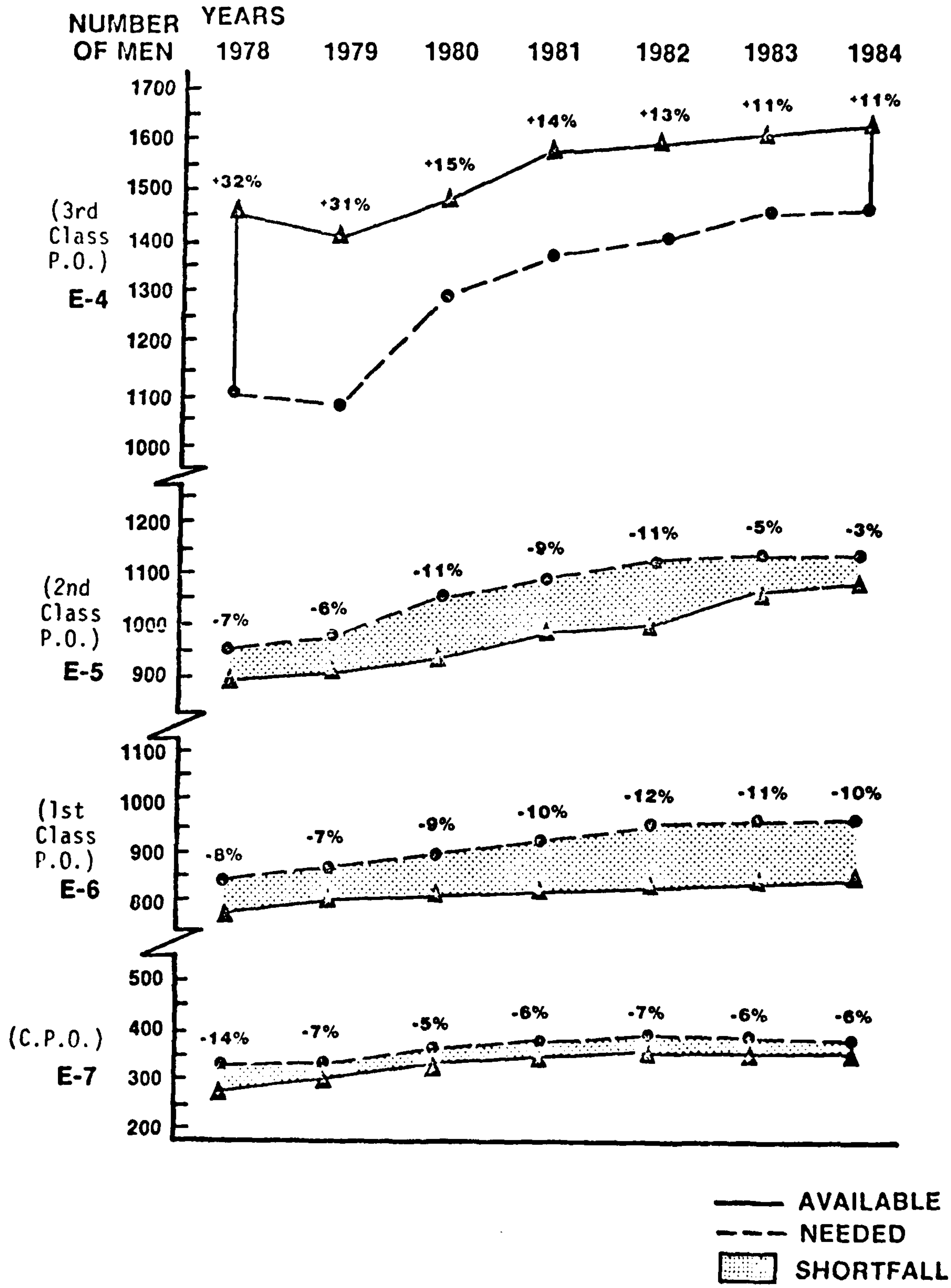


Figure 13. STG (Sonar Technician, Surface).

SECTION 5

EVALUATION OF ALTERNATIVES

ADDRESSING QUESTION 5

> In view of the answers to Questions 1 through 4, which general design alternative best satisfies not only manpower and training criteria but cost, potential benefit, and technical risk considerations?

The purpose of this section is to aid the designer in conducting early tradeoff analyses involving human resources and other design criteria. Figure 14 shows where in the process this occurs.

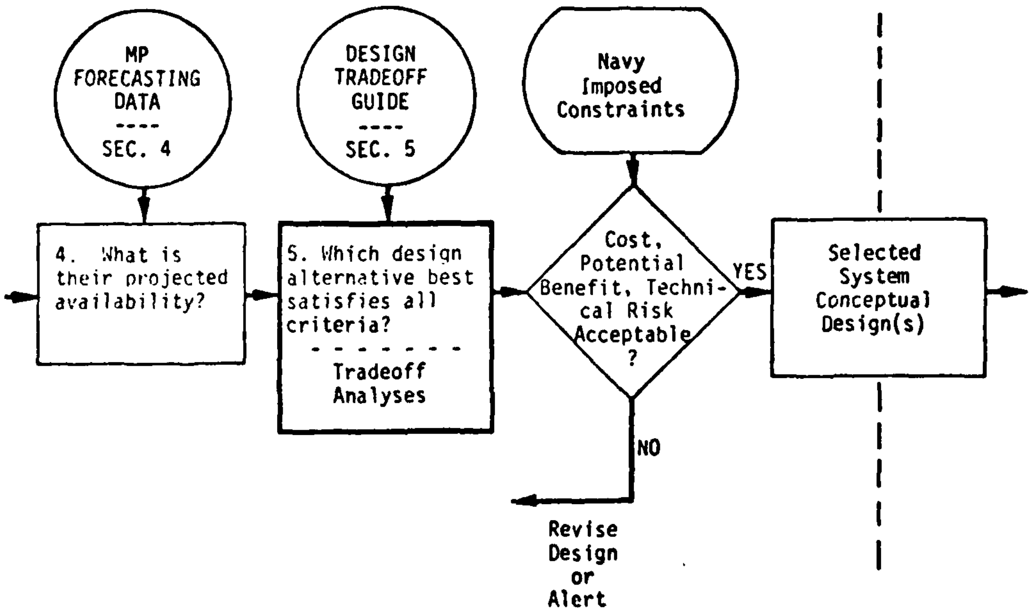


Figure 14. Addressing Question 5.

CONDUCTING THE TRADEOFFS

How are the design tradeoffs conducted?

The tradeoff technique described in this section makes use of the data in the evaluative profiles shown in Sections 1 and 2. This is not meant to imply that the designer or program manager will take into account only the information presented in those sections. For example, personnel supply at different skill levels (Section 4) certainly should be considered. Independent estimates of the technical feasibility of successfully implementing various design concepts may be made and other externally generated considerations very likely will be brought to bear.

However, the method provided here is a very easy way to evaluate the impact of all of the 21 design concepts defined in Section 1 that apply to the design under consideration, as they interact in relation to the 14 criteria identified in Section 2.

USE OF THE WORKSHEETS

Five worksheets are used to list those design concepts that apply to each system design being evaluated.

These worksheets, examples of which follow, are titled:

1. Maintenance Factors (1)
2. Maintenance Factors (2)
3. Operating Factors
4. General Criteria
5. System Design Evaluation Summary

The first four worksheets contain an "Impact Index" for different design concepts that may be applicable to one or more designs under

consideration. These indices are the same values that appeared in Sections 1 and 2. Positive values reflect a favorable impact on the system criterion in question, negative values an unfavorable impact.

ENTERING THE IMPACT INDICES

> For each system design, one of which may be a baseline system, the analyst simply enters the Impact Index for each concept that applies.

For example, consider two systems that had the following design features:

	Design A	Design B
1. Equipment layout to facilitate maintenance	✓	✓
2. LRUs--No spares		
3. LRUs--Spares with onboard repair	✓	
4. LRUs--Spares with remote repair		
5. LRUs--Spares with throwaway maintenance		✓
6. "Overdesign" for reliability & maintenance		
7. Embedded computers		✓
8. Automatic performance monitoring		✓
9. Built-in test equipment	✓	✓
10. Built-in troubleshooting logic aids		✓
11. Automatic fault localization		
12. Standard hardware components	✓	✓
13. Standard hardware--Cards/LRUs		✓
14. Standard hardware--Functional units		
15. Standard hardware--Subsystems		
16. Operational simplicity	✓	
17. Built-in operator performance aids		✓
18. Automatic decision making		
19. Automatic information transmit & display		✓
20. Built-in training capability		✓
21. Combined operator/maintainer functions		

Filling out each worksheet in turn, the analyst enters the Impact Index for each applicable design concept as it applies to each evaluative criterion on that worksheet. An example of a filled-in Worksheet 1 for the above two systems is shown on page 5-7. Completed Worksheets 2, 3, and 4 are shown on subsequent pages.

SUMMATION OF INDICES

> The indices entered on each worksheet are algebraically summed and transferred to the System Design Evaluation Summary.

The values in each column of each worksheet are summed algebraically to arrive at a total impact score for each criterion variable. Then, the final step is to transfer these scores to the System Design Evaluation Summary sheet.

The results of this process for our two example systems are shown on page 5-11. In the example, it is evident that Design A is generally evaluated superior to Design B on the basis of most maintainability criteria, but Design B is rated greatly superior on operational criteria. However, Design B's advantage in this respect is seen as coming at a considerably higher initial acquisition cost. Reexamination of Worksheet 4 reveals that the high initial acquisition cost stems from not one but several different concepts employed in Design B. The next step in an iterative process would be to see whether one or more different concepts might be substituted in the interest of lower cost without seriously impacting the operational advantage.

TOWARD A SINGLE OVERALL EVALUATIVE INDEX

> Can all the scores on the System Design Evaluation Summary be summed into a single index?

It is tempting to perform a second algebraic summation of all of the values entered on the System Design Evaluation Summary sheet. This

would permit the merits of the two systems to be compared on the basis of a single overall index. It should be noted that this procedure can be defended only if the analyst views all 14 evaluative criteria as equally important to the total design objective. If he does not, the 14 criteria must be differentially weighted on the basis of some externally imposed system of values before the summation takes place.

WORKSHEET 1
MAINTENANCE FACTORS (1)

	A. SKILL LEVEL REQUIRED				B. SYSTEM-SPECIFIC TRAINING REQUIRED				C. MAINTENANCE MAN-HOURS REQUIRED				D. MTBF			
	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C
1. Equipment layout to facilitate maintenance	+8	8	8		+6	6	6		+23	23	23		0	0	0	
2. LRUs--No spares	-1				-5				0*				0			
3. LRUs--Spares with onboard repair	-2*	-2			-6	-6			0*	0			0	0		
4. LRUs--Spares with remote repair	+14				+12				+18				0			
5. LRUs--Spares with throwaway maintenance	+16		16		+14		14		+18		18		0		0	
6. "Overdesign" for reliability & maintenance	0				0				+17				+32			
7. Embedded computers	-15		-15		-13		-13		-12		-12		-4*		-4	
8. Automatic performance monitoring	+4		4		-3*		-3		+6		6		-5*		-5	
9. Built-in test equipment	+11	11	11		+5	5	5		+16	16	16		-6	-6	-6	
10. Built-in troubleshooting logic aids	+15				+16				+24				-5			
11. Automatic fault localization	+21				+20				+31				-8			
12. Standard hardware components	+4	4	4		+4	4	4		+4	4	4		+3	3	3	
13. Standard hardware--Cards/LRUs	+7		7		+7		7		+5		5		+3		3	
14. Standard hardware--Functional units	+7				+8				+6				+3			
15. Standard hardware--Subsystems	+6				+8				+7				+3			
16. Operational simplicity	+5	5			+7	7			+3	3			+11			
17. Built-in operator performance aids	-7		-7		-8		-8		-5		-5		-7		-7	
18. Automatic decision making	-15				-20				-11				-13			
19. Automatic information transmit & display	-13		-13		-11		-11		-11		-11		-11		-11	
20. Built-in training capability	-11		-11		-10		-10		-6		-6		-9		-9	
21. Combined operator/maintainer functions	-4				-12				0*				0			
	Σ	26	4		Σ	16	-9		Σ	46	38		Σ	-3	-36	

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WORKSHEET 2
MAINTENANCE FACTORS (2)

	E. MTTR				F. TOOLS, TEST EQUIPMENT & FACILITIES				G. SUPPLY & SUPPORT COSTS			
	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C
1. Equipment layout to facilitate maintenance	+22	22	22		+3	3	3		0	0	0	
2. LRUs--No spares	+2*				-1				+2*			
3. LRUs--Spares with onboard repair	+12	12			-3	-3			+2*	2		
4. LRUs--Spares with remote repair	+17				0*				-11			
5. LRUs--Spares with throwaway maintenance	+17		17		+12		12		-20		-20	
6. "Overdesign" for reliability & maintenance	0				+1				+4*			
7. Embedded computers	-6		-6		-6		-6		-12		-12	
8. Automatic performance monitoring	+7		7		+2*		2		-7		-7	
9. Built-in test equipment	+23	23	23		+15	15	15		-4*	-4	-4	
10. Built-in troubleshooting logic aids	+28				+7				-2			
11. Automatic fault localization	+40				+12				-3*			
12. Standard hardware components	+6	6	6		+7	7	7		+14	14	14	
13. Standard hardware--Cards/LRUs	+9		9		+8		8		+15		15	
14. Standard hardware--Functional units	+9				+9				+14			
15. Standard hardware--Subsystems	+8				+9				+15			
16. Operational simplicity	+6	6			+2	2			+6	6		
17. Built-in operator performance aids	-2		-2		-5		-5		-10		-10	
18. Automatic decision making	-5				-5				-14			
19. Automatic information transmit & display	-6		-6		-6		-6		-8		-8	
20. Built-in training capability	-2		-2		-5		-5		-10		-10	
21. Combined operator/maintainer functions	0				0				0			
	Σ	69	68		Σ	24	25		Σ	18	-42	

WORKSHEET 3
OPERATING FACTORS

	H. OPERATOR SKILL & EXPERIENCE REQUIRED				I. SYSTEM-SPECIFIC OPERATOR TRAINING REQ.				J. TOTAL NUMBER OF OPERATORS REQUIRED				K. SYSTEM OPERABILITY			
	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C
1. Equipment layout to facilitate maintenance	0	0	0		0	0	0		0	0	0		0	0	0	
2. LRUs--No spares	0				0				0				0			
3. LRUs--Spares with onboard repair	0	0			0	0			0	0			0	0		
4. LRUs--Spares with remote repair	0				0				0				0			
5. LRUs--Spares with throwaway maintenance	0		0		0		0		0		0		0		0	
6. "Overdesign" for reliability & maintenance	0				0				0				0			
7. Embedded computers	0		0		0		0		+3		3		+4		4	
8. Automatic performance monitoring	+6		6		+6		6		+2		2		+6		6	
9. Built-in test equipment	0	0	0		0	0	0		0	0	0		0	0	0	
10. Built-in troubleshooting logic aids	0				0				0				0			
11. Automatic fault localization	0				0				0				0			
12. Standard hardware components	0	0	0		0	0	0		0	0	0		0	0	0	
13. Standard hardware--Cards/LRUs	0		0		0		0		0		0		0		0	
14. Standard hardware--Functional units	0				0				0				0			
15. Standard hardware--Subsystems	+4				+3				0				0			
16. Operational simplicity	+18	18			+24	24			+11	11			+21	21		
17. Built-in operator performance aids	+16		16		+18		18		+9		9		+22		22	
18. Automatic decision making	+22				+20				+16				+26			
19. Automatic information transmit & display	+6*		6		+4*		4		+19		19		+20		20	
20. Built-in training capability	+6		6		+11		11		0		0		+10		10	
21. Combined operator/maintainer functions	-23				-29				-5*				0			
	Σ	18	34		Σ	24	39		Σ	11	33		Σ	21	52	

WORKSHEET 4
GENERAL CRITERIA

	L. OVERALL OPERATIONAL CAPABIL. & EFFECTIVENESS				M. INITIAL SYSTEM ACQUISITION COSTS				N. OPERATIONAL LIFETIME COSTS			
	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C
1. Equipment layout to facilitate maintenance	+7	7	7		-4	-4	-4		+4	4	4	
2. LRUs--No spares	0*				-2*				0			
3. LRUs--Spares with onboard repair	+5	5			-3	-3			0	0		
4. LRUs--Spares with remote repair	+5				-3				-3*			
5. LRUs--Spares with throwaway maintenance	+7		7		-4		-4		-8		-8	
6. "Overdesign" for reliability & maintenance	+16				-20				+20			
7. Embedded computers	+8		8		-15		-15		-5		-5	
8. Automatic performance monitoring	+22		22		-19		-19		-3*		-3	
9. Built-in test equipment	+12	12	12		-21	-21	-21		+3*	3	3	
10. Built-in troubleshooting logic aids	+15				-20				+2*			
11. Automatic fault localization	+21				-27				+3*			
12. Standard hardware components	+3	3	3		+8	8	8		+9	9	9	
13. Standard hardware--Cards/LRUs	+4		4		+8		8		+11		11	
14. Standard hardware--Functional units	+5				+10				+12			
15. Standard hardware--Subsystems	+5				+10				+12			
16. Operational simplicity	+7*	7			+9	9			+5	5		
17. Built-in operator performance aids	+17		17		-19		-19		-11		-11	
18. Automatic decision making	+26				-29				-12			
19. Automatic information transmit & display	+25		25		-23		-23		-7		-7	
20. Built-in training capability	+13		13		-20		-20		-7		-7	
21. Combined operator/maintainer functions	0				0				0			
	Σ	34	118		Σ	-11	-109		Σ	21	-14	

WORKSHEET 5
SYSTEM DESIGN EVALUATION SUMMARY

	Design A	Design B	Design C
A. Maintainer skill & experience level required	26	4	
B. System-specific maint. training required	16	-9	
C. Maintenance man-hours required	46	38	
D. MTBF	-3	-36	
E. MTTR	69	68	
F. Tools, test equip., facilities required	24	25	
G. Supply and support costs	18	-42	
H. Operator skill & experience required	18	34	
I. System-specific oper. training required	24	39	
J. Total number of operators required	11	33	
K. System operability	21	52	
L. Overall oper. capability & effectiveness	34	118	
M. Initial system acquisition costs	-11	-109	
N. Operational lifetime costs	21	-14	

EXTRA WORKSHEETS

WORKSHEET 1
MAINTENANCE FACTORS (1)

	A. SKILL LEVEL REQUIRED				B. SYSTEM-SPECIFIC TRAINING REQUIRED				C. MAINTENANCE MAN-HOURS REQUIRED				D. MTBF			
	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C
1. Equipment layout to facilitate maintenance	+8				+6				+23				0			
2. LRUs--No spares	-1				-5				0*				0			
3. LRUs--Spares with onboard repair	-2*				-6				0*				0			
4. LRUs--Spares with remote repair	+14				+12				+18				0			
5. LRUs--Spares with throwaway maintenance	+16				+14				+18				0			
6. "Overdesign" for reliability & maintenance	0				0				+17				+32			
7. Embedded computers	-15				-13				-12				-4*			
8. Automatic performance monitoring	+4				-3*				+6				-5*			
9. Built-in test equipment	+11				+5				+16				-6			
10. Built-in troubleshooting logic aids	+15				+16				+24				-5			
11. Automatic fault localization	+21				+20				+31				-8			
12. Standard hardware components	+4				+4				+4				+3			
13. Standard hardware--Cards/LRUs	+7				+7				+5				+3			
14. Standard hardware--Functional units	+7				+8				+6				+3			
15. Standard hardware--Subsystems	+6				+8				+7				+3			
16. Operational simplicity	+5				+7				+3				+11			
17. Built-in operator performance aids	-7				-8				-5				-7			
18. Automatic decision making	-15				-20				-11				-13			
19. Automatic information transmit & display	-13				-11				-11				-11			
20. Built-in training capability	-11				-10				-6				-9			
21. Combined operator/maintainer functions	-4				-12				0*				0			
	Σ				Σ				Σ				Σ			

WORKSHEET 2
MAINTENANCE FACTORS (2)

	E. MTTR				F. TOOLS, TEST EQUIPMENT & FACILITIES				G. SUPPLY & SUPPORT COSTS			
	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C
1. Equipment layout to facilitate maintenance	+22				+3				0			
2. LRUs--No spares	+2*				-1				+2*			
3. LRUs--Spares with onboard repair	+12				-3				+2*			
4. LRUs--Spares with remote repair	+17				0*				-11			
5. LRUs--Spares with throwaway maintenance	+17				+12				-20			
6. "Overdesign" for reliability & maintenance	0				+1				+4*			
7. Embedded computers	-6				-6				-12			
8. Automatic performance monitoring	+7				+2*				-7			
9. Built-in test equipment	+23				+15				-4*			
10. Built-in troubleshooting logic aids	+28				+7				-2			
11. Automatic fault localization	+40				+12				-3*			
12. Standard hardware components	+6				+7				+14			
13. Standard hardware--Cards/LRUs	+9				+8				+15			
14. Standard hardware--Functional units	+9				+9				+14			
15. Standard hardware--Subsystems	+8				+9				+15			
16. Operational simplicity	+6				+2				+6			
17. Built-in operator performance aids	-2				-5				-10			
18. Automatic decision making	-5				-5				-14			
19. Automatic information transmit & display	-6				-6				-8			
20. Built-in training capability	-2				-5				-10			
21. Combined operator/maintainer functions	0				0				0			
	Σ				Σ				Σ			

WORKSHEET 3
OPERATING FACTORS

	H. OPERATOR SKILL & EXPERIENCE REQUIRED				I. SYSTEM-SPECIFIC OPERATOR TRAINING REQ.				J. TOTAL NUMBER OF OPERATORS REQUIRED				K. SYSTEM OPERABILITY			
	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C
1. Equipment layout to facilitate maintenance	0				0				0				0			
2. LRUs--No spares	0				0				0				0			
3. LRUs--Spares with onboard repair	0				0				0				0			
4. LRUs--Spares with remote repair	0				0				0				0			
5. LRUs--Spares with throwaway maintenance	0				0				0				0			
6. "Overdesign" for reliability & maintenance	0				0				0				0			
7. Embedded computers	0				0				+3				+4			
8. Automatic performance monitoring	+6				+6				+2				+6			
9. Built-in test equipment	0				0				0				0			
10. Built-in troubleshooting logic aids	0				0				0				0			
11. Automatic fault localization	0				0				0				0			
12. Standard hardware components	0				0				0				0			
13. Standard hardware--Cards/LRUs	0				0				0				0			
14. Standard hardware--Functional units	0				0				0				0			
15. Standard hardware--Subsystems	+4				+3				0				0			
16. Operational simplicity	+18				+24				+11				+21			
17. Built-in operator performance aids	+16				+18				+9				+22			
18. Automatic decision making	+22				+20				+16				+26			
19. Automatic information transmit & display	+6*				+4*				+19				+20			
20. Built-in training capability	+6				+11				0				+10			
21. Combined operator/maintainer functions	-23				-29				-5*				0			
	Σ				Σ				Σ				Σ			

WORKSHEET 4
GENERAL CRITERIA

	L. OVERALL OPERATIONAL CAPABIL. & EFFECTIVENESS				M. INITIAL SYSTEM ACQUISITION COSTS				N. OPERATIONAL LIFETIME COSTS			
	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C	Impact Index	Design A	Design B	Design C
1. Equipment layout to facilitate maintenance	+7				-4				+4			
2. LRUs--No spares	0*				-2*				0			
3. LRUs--Spares with onboard repair	+5				-3				0			
4. LRUs--Spares with remote repair	+5				-3				-3*			
5. LRUs--Spares with throwaway maintenance	+7				-4				-8			
6. "Overdesign" for reliability & maintenance	+16				-20				+20			
7. Embedded computers	+8				-15				-5			
8. Automatic performance monitoring	+22				-19				-3*			
9. Built-in test equipment	+12				-21				+3*			
10. Built-in troubleshooting logic aids	+15				-20				+2*			
11. Automatic fault localization	+21				-27				+3*			
12. Standard hardware components	+3				+8				+9			
13. Standard hardware--Cards/LRUs	+4				+8				+11			
14. Standard hardware--Functional units	+5				+10				+12			
15. Standard hardware--Subsystems	+5				+10				+12			
16. Operational simplicity	+7*				+9				+5			
17. Built-in operator performance aids	+17				-19				-11			
13. Automatic decision making	+26				-29				-12			
19. Automatic information transmit & display	+25				-23				-7			
20. Built-in training capability	+13				-20				-7			
21. Combined operator/maintainer functions	0				0				0			
	Σ				Σ				Σ			

WORKSHEET 5
SYSTEM DESIGN EVALUATION SUMMARY

	Design A	Design B	Design C
A. Maintainer skill & experience level required			
B. System-specific maint. training required			
C. Maintenance man-hours required			
D. MTBF			
E. MTTR			
F. Tools, test equip., facilities required			
G. Supply and support costs			
H. Operator skill & experience required			
I. System-specific oper. training required			
J. Total number of operators required			
K. System operability			
L. Overall oper. capability & effectiveness			
M. Initial system acquisition costs			
N. Operational lifetime costs			

SECTION 6

TAXONOMIES OF TASKS AND ASSOCIATED SKILL LEVELS

ADDRESSING QUESTION 6

> What is the impact of the preferred system design on specific operator and maintainer tasks?

To answer Question 6 it is necessary to move from the conceptual level of analysis, occurring very early in the design process, to a more detailed task and skill level analysis. In the sequence of steps involved in using human resources data as a design factor, we are at the point shown in Figure 15.

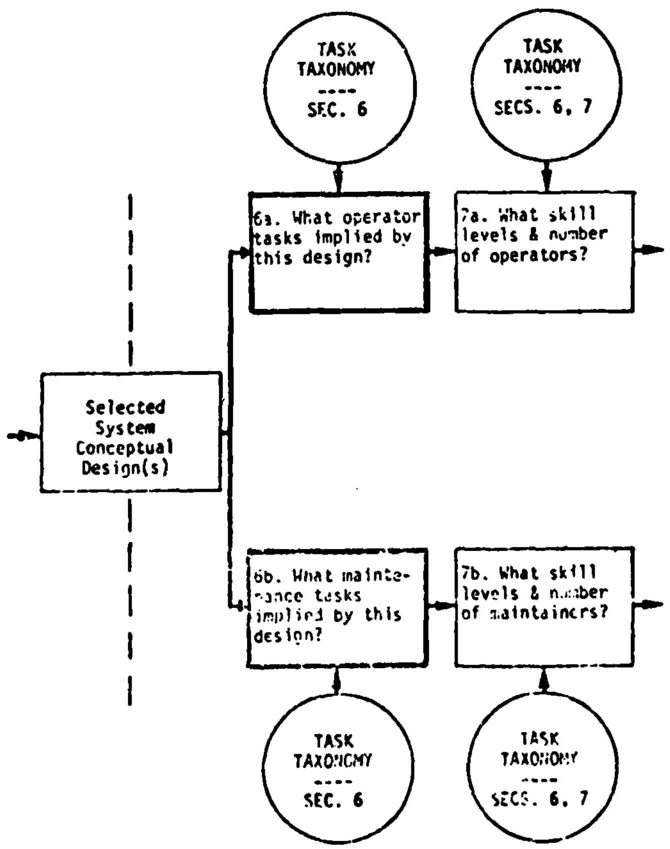


Figure 15. Addressing Question 6.

EXISTING SYSTEMS SERVE AS THE REFERENCE

> Each task level analysis can be facilitated by reference to tasks performed in operational systems of the same general type as that being designed.

Conducting the necessary task analyses early in the conceptual and engineering phases of system development typically suffers from a lack of detailed information concerning specific tasks to be performed by the operators and maintainers. However, systems designed to perform similar functions involve similar human activities, and it is therefore possible to use task performance data from earlier systems as a point of departure.

SIMILARITIES AND DIFFERENCES

> The task analysis should focus on similarities and differences in the tasks to be performed.

The newly proposed design probably will include:

- Some tasks that are unique to the new system.
- Many tasks that are similar, if not identical to those performed in older systems of the same type.

Identification of the new tasks must necessarily depend upon knowledge of the new engineering design features, so this requirement can be addressed here only in the sense that the task taxonomies provide the basis for identifying which tasks are "old" and which are consequences of the new design. It is important to note, however, that new tasks are the source of new training requirements and quite possibly new NECs. Thus their proliferation is to be discouraged except where they involve simplification or elimination of old tasks, particularly those older tasks that were especially difficult or time consuming to perform (Section 7).

DIFFICULTY LEVELS FOR PERSONNEL OF DIFFERENT EXPERIENCE

> The task taxonomies provide the designer with a means of determining the task difficulty levels and corresponding personnel skill levels for most tasks of the type that his system will generate.

The subsections that follow contain comprehensive inventories of the tasks performed aboard ship by DS, ET(N), ET(R), FTM, RM, and STG personnel. At the beginning of each subsection, an index is provided that shows where task data relating to general operation/maintenance activities can be found as well as task data associated with specific subsystems.

Skill data are also presented in the form of profiles showing the level of proficiency associated with typical Fleet personnel at the 3rd, 2nd, and 1st class petty officer grades. These skill profiles reflect the averaged judgments of substantial numbers of senior chief petty officers with recent, extensive supervisory experience with shipboard personnel in their rating specialty. The descriptors employed on the proficiency profiles have the following meanings:

LIMITED: Can do simple parts of the task. Needs to be told or shown how to do most of the task.

PARTIAL: Can do most parts of the task. Needs help only on the hardest parts. May not perform the task with the desired speed or accuracy.

COMPETENT: Can do all parts of the task. Needs only a spot check of completed work. Generally meets required standards for speed and accuracy.

SUPERIOR: Superior in accurately and quickly performing the task. No checkup needed. Can instruct others how to do the task.

ALL TASKS SHOULD BE CONSIDERED

The designer should consider the impact of his design on all applicable operator and maintainer tasks.

For example, if the system under development is a data processing system that calls for the skills of Data Systems Technicians, the designer should turn first to the DS section and identify from the index (page 6-7) the general tasks performed by these personnel that are applicable to his system as well as the subsystem tasks that apply. (In doing this, he should pay particular attention to any proposed subsystems whose tasks may not be covered by the taxonomy since these will probably generate new training requirements.)

The index of DS tasks shows that tasks associated with "General Operation" are to be found on page 6-8. Turning to that page, the designer will find 7 general operations tasks listed together with skill level profiles for 3rd, 2nd, and 1st class petty officers. It will be seen that all three grades of petty officers are viewed as "competent" for the first 3 tasks, but that only 1st class petty officers are considered "competent" for the last task which involves initiating communications links.

In this manner, the designer can determine the experience level required for competency in each task applicable to the system under development.

PREDECESSOR SYSTEMS ARE IDENTIFIED

The systems on which the skill level profiles are based are identified.

Each task in the inventory was considered by senior technicians as it is performed in systems for which they had primary responsibility.

Usually the tasks apply to several different systems though they may not be performed in quite the same way in each system.

To the right of each task description the systems used for reference in judging the associated required skill levels are listed. Thus, for the first task listed for DSs on page 6-8, the systems considered included:

UYK-5	UYA-4
UYK-20	UYK-7
LHA	NTDS-3
NTDS-CV	USQ-20

Statistical tests were made of the differences in judged difficulty levels for each task as performed in the several different systems. These were, for the most part, insignificant. Where they were significantly different, the task is listed separately for each system as appropriate.

Each judge also indicated whether or not he felt each task was particularly time consuming. These results, in the form of the percentage of raters who judged each task to be time consuming, are shown to the right side of the profile along with the applicable system identifiers. Unanimity of opinion on this point was unlikely since different systems provided different frames of reference. However, there was relatively strong agreement that some tasks are generally more time consuming than others. For convenience, these and all particularly difficult tasks have been listed separately in Section 7.

Some of the task-skill level judgments were made by too few supervisors to ensure reliable results. Those based on just 3, 4, or 5 raters have been marked with an *, but the skill profile is nevertheless shown. Those tasks for which there were only 1 or 2 judges are listed in the inventory for the sake of completeness but no skill profiles are presented.

USING THE TAXONOMIES

> The taxonomies should be used as a checkoff list.

The designer should use the information presented in these taxonomies as a checklist against which to assess the scope and probable difficulty levels of the tasks to be performed by the operators and maintainers of his system. He should pay particular attention to:

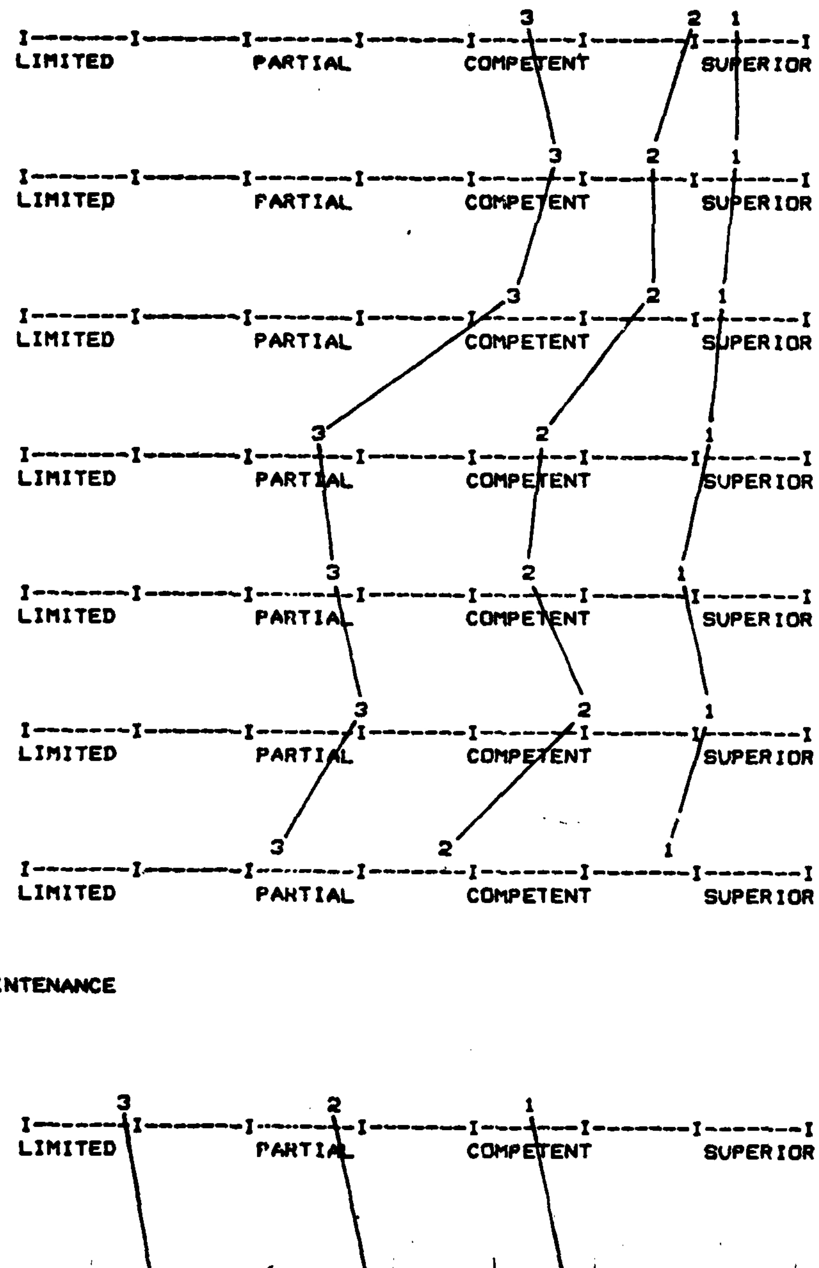
- New tasks, not appearing in the list, which have significant implications for new training requirements.
- Listed tasks that are particularly difficult.
- Listed tasks that are particularly time consuming.

His general design objective should be to minimize the number of tasks in each of the above categories and to maximize the likelihood of "competent" performance by 3rd class petty officers.

Further use of the data in the task taxonomies is described in the next section which is concerned with particularly difficult and time consuming tasks.

INDEX OF TASKS PERFORMED BY DSs

DS: GENERAL OPERATION



	Time consuming	
PERFORM POWER UP/DOWN PROCEDURES ON DATA PROCESSING EQUIPMENT	4%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
LOAD PRINTER PAPER IN DATA PROCESSING EQUIPMENT	7%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
LOAD MAGNETIC TAPE/DISK PACKS IN DATA PROCESSING EQUIPMENT	9%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
LOAD/RUN DIAGNOSTIC/TEST PROGRAMS	19%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
LOAD OPERATION PROGRAM FROM SYSTEM MONITORING PANEL (SMP)	4%	UYK-5, UYA-4, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
PLACE EQUIPMENT ON/OFF LINE USING SMP	0%	UYK-5, UYA-4, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
INITIATE COMMUNICATIONS LINKS SUCH AS LINK 11, LINK 4A, LINK 14	0%	UYA-4, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20

DS: GENERAL SOFTWARE MAINTENANCE

	Time consuming	
WRITE/REWRITE PROGRAMS (MAINTENANCE, OPERATIONAL)	50%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20

TEST NEW PROGRAMS (MAINTENANCE, OPERATIONAL)	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 33%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
DEBUG PROGRAMS (MAINTENANCE, OPERATIONAL)	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 48%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
MAKE AUTHORIZED CHANGES TO PROGRAMS	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 11%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20

DS: GENERAL HARDWARE MAINTENANCE

RESEARCH TECHNICAL PUBLICATIONS TO FIND APPROPRIATE SCHEMATICS/LOGIC DIAGRAMS/TABLES/TROUBLESHOOTING CHARTS/MAINTENANCE INFORMATION/PART NUMBERS FOR SPECIFIC PIECES OF EQUIPMENT	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 19%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
IDENTIFY STANDARD ELECTRONIC/MECHANICAL SYMBOLS AS USED ON SCHEMATICS, LOGIC DIAGRAMS, FLOW CHARTS, ETC.	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 0%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
MODIFY EQUIPMENT IN ACCORDANCE WITH SHIPALTS, ORDALTS, FIELD CHANGE ORDERS AND ELECTRONIC INFORMATION BULLETINS (EIBS)	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 40%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
CHANGE SYSTEM CONFIGURATION BY PATCHING OR BY SWITCHBOARD CHANGES	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 3%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
ANALYZE EQUIPMENT FRONT PANEL INDICATORS FOR FAULT DETECTION	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 0%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
USE TEST EQUIPMENT TO INJECT SIGNALS AND/OR TAKE READINGS	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 2%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USG-20

ASSEMBLE/REPAIR CABLES AND TEST LEADS, SUCH AS CONNECTORS, PROBES, ETC.

LIMITED — PARTIAL — COMPETENT — SUPERIOR

TIME CONSUMING: 37%
UYK-5 UYA-4
UYK-20 UYK-7
LHA NTDS-3
NTDS-CV USQ-20

ALIGN/ADJUST MECHANICAL LINKAGES AND GEAR TRAINS

LIMITED — PARTIAL — COMPETENT — SUPERIOR

TIME CONSUMING: 31%
UYK-5 UYA-4
UYK-20 LHA
NTDS-3 NTDS-CV
USQ-20

LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A SUBSYSTEM

LIMITED — PARTIAL — COMPETENT — SUPERIOR

TIME CONSUMING: 5%
UYK-5 UYA-4
UYK-20 UYK-7
LHA NTDS-3
NTDS-CV USQ-20

LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A UNIT

LIMITED — PARTIAL — COMPETENT — SUPERIOR

TIME CONSUMING: 2%
UYK-5 UYA-4
UYK-20 UYK-7
LHA NTDS-3
NTDS-CV USQ-20

DS: A-TO-D & D-TO-A CONVERTERS

CLEAN/LUBRICATE A TO D AND D TO A CONVERTERS

LIMITED — PARTIAL — COMPETENT — SUPERIOR

TIME CONSUMING: 11%
UYA-4 LHA
NTDS-3 NTDS-CV
USQ-20

TEST/INSPECT A TO D AND D TO A CONVERTERS

LIMITED — PARTIAL — COMPETENT — SUPERIOR

TIME CONSUMING: 0%
UYA-4 UYK-7
LHA NTDS-3
NTDS-CV USQ-20

LOCALIZE/ISOLATE A TO D AND D TO A CONVERTERS MALFUNCTION TO THE MODULE/CARD LEVEL

LIMITED — PARTIAL — COMPETENT — SUPERIOR

TIME CONSUMING: 10%
UYA-4 UYK-7
LHA NTDS-3
NTDS-CV USQ-20

LOCALIZE/ISOLATE A TO D AND D TO A CONVERTERS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

LIMITED — PARTIAL — COMPETENT — SUPERIOR

TIME CONSUMING: 15%
UYA-4 UYK-7
LHA NTDS-3
NTDS-CV USQ-20

REMOVE/REPLACE A TO D AND D TO A CONVERTERS MODULES/CARDS

LIMITED — PARTIAL — COMPETENT — SUPERIOR

TIME CONSUMING: 5%
UYA-4 UYK-20
UYK-7 LHA
NTDS-3 NTDS-CV
USQ-20

Task	Scale	Time consuming	Systems
REMOVE/REPLACE A TO D AND D TO A CONVERTERS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED – PARTIAL – COMPETENT – SUPERIOR	15%	UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
CALIBRATE/ALIGN/ADJUST A TO D AND D TO A CONVERTERS	LIMITED – PARTIAL – COMPETENT – SUPERIOR	31%	UYA-4, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20

DS. CARD READER

Task	Scale	Time consuming	Systems
CLEAN/LUBRICATE CARD READER	LIMITED – PARTIAL – COMPETENT – SUPERIOR	13%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20
TEST/INSPECT CARD READER	LIMITED – PARTIAL – COMPETENT – SUPERIOR	14%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20
LOCALIZE/ISOLATE CARD READER MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED – PARTIAL – COMPETENT – SUPERIOR	18%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20
LOCALIZE/ISOLATE CARD READER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED – PARTIAL – COMPETENT – SUPERIOR	23%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20
REMOVE/REPLACE CARD READER MODULES/CARDS	LIMITED – PARTIAL – COMPETENT – SUPERIOR	0%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20
REMOVE/REPLACE CARD READER COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED – PARTIAL – COMPETENT – SUPERIOR	14%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20
CALIBRATE/ALIGN/ADJUST CARD READER	LIMITED – PARTIAL – COMPETENT – SUPERIOR	47%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20

DS: CARD PUNCH

CLEAN/LUBRICATE CARD PUNCH	3 2 1	I------I------I------I------I------I------I------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 14% UYK-5 UYK-20 LHA NTDS-CV USQ-20
TEST/INSPECT CARD PUNCH	3 2 1	I------I------I------I------I------I------I------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 14% UYK-5 UYK-20 LHA NTDS-CV USQ-20
LOCALIZE/ISOLATE CARD PUNCH MALFUNCTION TO THE MODULE/CARD LEVEL	3 2 1	I------I------I------I------I------I------I------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 14% UYK-5 UYK-20 LHA NTDS-CV USQ-20
LOCALIZE/ISOLATE CARD PUNCH MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3 2 1	I------I------I------I------I------I------I------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 25% UYK-5 UYK-20 LHA NTDS-CV USQ-20
REMOVE/REPLACE CARD PUNCH MODULES/CARDS	3 2 1	I------I------I------I------I------I------I------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 0% UYK-5 UYK-20 LHA NTDS-CV USQ-20
REMOVE/REPLACE CARD PUNCH MODULES/CARDS	3 2 1	I------I------I------I------I------I------I------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 0% UYK-5 UYK-20 LHA NTDS-CV USQ-20
CALIBRATE/ALIGN/ADJUST CARD PUNCH	3 2 1	I------I------I------I------I------I------I------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 42% UYK-5 UYK-20 LHA NTDS-CV USQ-20

DS: CHILLED WATER SYSTEM

CLEAN COOLING CHILLED WATER SYSTEM	3 2 1	I------I------I------I------I------I------I------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 40% UYA-4 LHA NTDS-3 NTDS-CV USQ-20

		Time consuming	
TEST/INSPECT COOLING CHILLED WATER SYSTEM	LIMITED / PARTIAL / COMPETENT / SUPERIOR	21%	UYA-4, LHA, NTDS-3, NTDS-CV, USQ-20
LOCALIZE/ISOLATE COOLING CHILLED WATER SYSTEM MALFUNCTION TO A UNIT	LIMITED / PARTIAL / COMPETENT / SUPERIOR	5%	UYA-4, LHA, NTDS-3, NTDS-CV, USQ-20
LOCALIZE/ISOLATE COOLING CHILLED WATER SYSTEM MALFUNCTION TO THE PART LEVEL	LIMITED / PARTIAL / COMPETENT / SUPERIOR	11%	UYA-4, LHA, NTDS-3, NTDS-CV, USQ-20
REMOVE/REPLACE COOLING CHILLED WATER SYSTEM PARTS	LIMITED / PARTIAL / COMPETENT / SUPERIOR	42%	UYA-4, LHA, NTDS-3, NTDS-CV, USQ-20
CALIBRATE/ALIGN/ADJUST COOLING CHILLED WATER SYSTEM	LIMITED / PARTIAL / COMPETENT / SUPERIOR	7%	UYA-4, LHA, NTDS-3, NTDS-CV, USQ-20

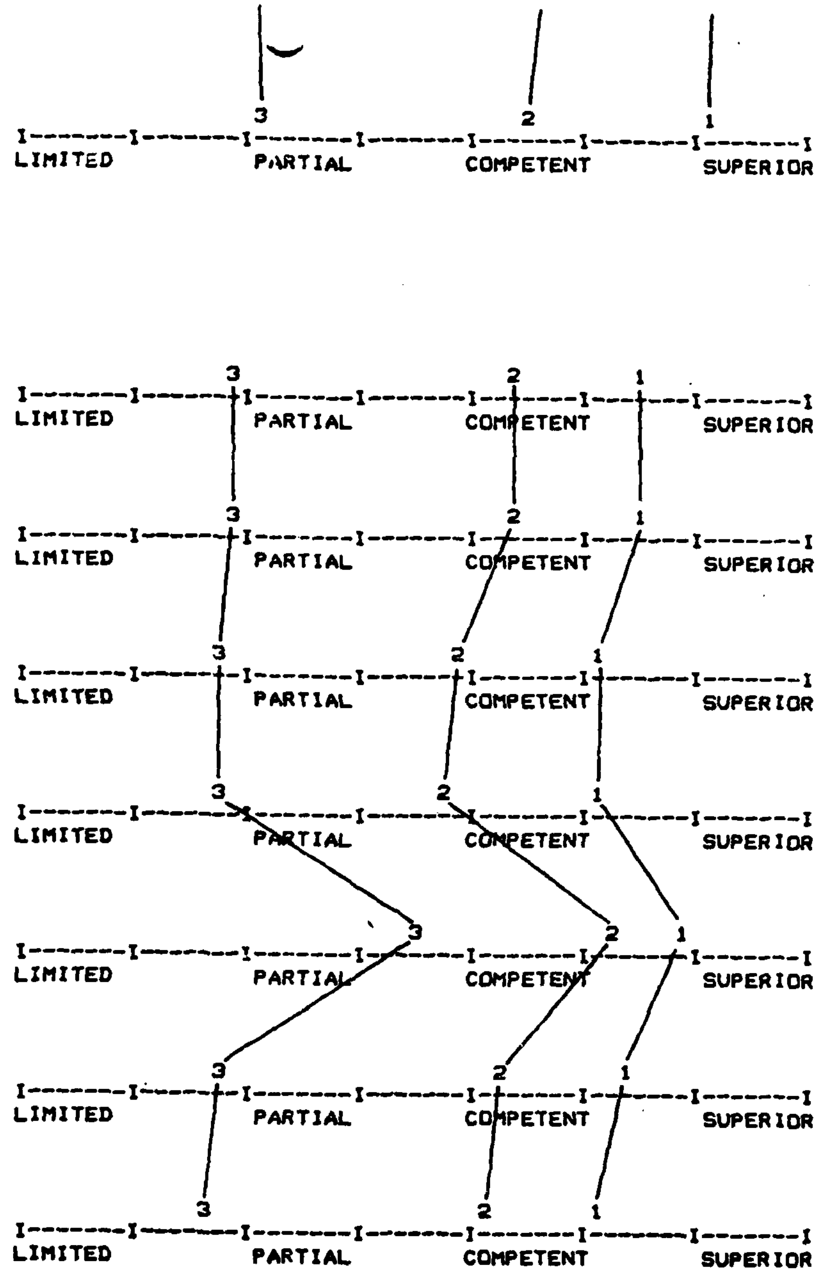
DS: CIRCUIT CARD TEST SET

		Time consuming	
CLEAN CIRCUIT CARD TEST SET	LIMITED / PARTIAL / COMPETENT / SUPERIOR	17%	UYA-4, UYK-20, LHA, NTDS-3, NTDS-CV
TEST/INSPECT CIRCUIT CARD TEST SET	LIMITED / PARTIAL / COMPETENT / SUPERIOR	16%	UYA-4, UYK-20, LHA, NTDS-3, NTDS-CV
LOCALIZE/ISOLATE CIRCUIT CARD TEST SET MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED / PARTIAL / COMPETENT / SUPERIOR	0%	UYA-4, UYK-20, LHA, NTDS-3, NTDS-CV
LOCALIZE/ISOLATE CIRCUIT CARD TEST SET MALFUNCTION TO THE COMPONENT LEVEL, SUCH	LIMITED / PARTIAL / COMPETENT / SUPERIOR	5%	UYA-4, UYK-20, LHA, NTDS-3

REMOVE/REPLACE CIRCUIT CARD TEST SET MODULES/CARDS	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 5% UYA-4 UYK-20 LHA NTDS-3 NTDS-CV
REMOVE/REPLACE CIRCUIT CARD TEST SET COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 10% UYA-4 UYK-20 LHA NTDS-3 NTDS-CV
CALIBRATE/ALIGN/ADJUST CIRCUIT CARD TEST SET	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 16% UYA-4 UYK-20 LHA NTDS-3 NTDS-CV

DS: COMPUTER ELECTRONICS

CLEAN DIGITAL COMPUTER ELECTRONICS	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 23% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
TEST/INSPECT DIGITAL COMPUTER ELECTRONICS	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 7% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
LOCALIZE/ISOLATE DIGITAL COMPUTER ELECTRONICS MALFUNCTION TO THE MODULE/CARD LEVEL	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 22% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
LOCALIZE/ISOLATE DIGITAL COMPUTER ELECTRONICS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 27% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
REMOVE/REPLACE DIGITAL COMPUTER ELECTRONICS MODULES/CARDS	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 12% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
REMOVE/REPLACE DIGITAL COMPUTER ELECTRONICS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 35% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20



Task	Time Consuming	Systems
CALIBRATE/ALIGN/ADJUST DIGITAL COMPUTER ELECTRONICS	33%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20

DS: DISK FILE

Task	Time Consuming	Systems
CLEAN/LUBRICATE DISK FILE	11%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20
TEST/INSPECT DISK FILE	11%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20
LOCALIZE/ISOLATE DISK FILE MALFUNCTION TO THE MODULE/CARD LEVEL	11%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20
LOCALIZE/ISOLATE DISK FILE MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	11%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20
REMOVE/REPLACE DISK FILE MODULES/CARDS	0%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20
REMOVE/REPLACE DISK FILE COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	11%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20
CALIBRATE/ALIGN/ADJUST DISK FILE	33%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20

DS: DATA ENTRY KEYSET CONSOLE

CLEAN DATA ENTRY KEYSET CONSOLE

```
                                 3              2  1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 20%
UYA-4 LHA
NTDS-3 NTDS-CV
USQ-20

TEST/INSPECT DATA ENTRY KEYSET CONSOLE

```
                                  3            2   1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 11%
UYA-4 LHA
NTDS-3 NTDS-CV
USQ-20

LOCALIZE/ISOLATE DATA ENTRY KEYSET CONSOLE MALFUNCTION TO THE MODULE/CARD LEVEL

```
                          3                 2          1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 7%
UYA-4 LHA
NTDS-3 NTDS-CV
USQ-20

LOCALIZE/ISOLATE DATA ENTRY KEYSET CONSOLE MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

```
                       3                    2          1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 6%
UYA-4 LHA
NTDS-3 NTDS-CV
USQ-20

REMOVE/REPLACE DATA ENTRY KEYSET CONSOLE MODULES/CARDS

```
                             3                 2       1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 7%
UYA-4 LHA
NTDS-3 NTDS-CV
USQ-20

REMOVE/REPLACE DATA ENTRY KEYSET CONSOLE COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

```
                      3                      2     1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 20%
UYA-4 LHA
NTDS-3 NTDS-CV
USQ-20

CALIBRATE/ALIGN/ADJUST DATA ENTRY KEYSET CONSOLE

```
                              3             21
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 10%
LHA NTDS-3
NTDS-CV USQ-20

DS: DATA TERMINAL SET

CLEAN/LUBRICATE DATA TERMINAL SET

```
                            3               2    1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 23%
UYA-4 UYK-7
LHA NTDS-3
NTDS-CV

TEST/INSPECT DATA TERMINAL SET

3 2 1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 0%
UYA-4 UYK-7
LHA NTDS-3
NTDS-CV

LOCALIZE-ISOLATE DATA TERMINAL SET MALFUNCTION TO THE MODULE/CARD LEVEL

3 2 1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 0%
UYA-4 UYK-7
LHA NTDS-3
NTDS-CV

LOCALIZE/ISOLATE DATA TERMINAL SET MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

3 2 1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 0%
UYA-4 UYK-7
LHA NTDS-3
NTDS-CV

REMOVE/REPLACE DATA TERMINAL SET MODULES/CARDS

3 2 1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 7%
UYA-4 UYK-7
LHA NTDS-3
NTDS-CV

REMOVE/REPLACE DATA TERMINAL SET COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

3 2 1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 0%
UYA-4 UYK-7
LHA NTDS-3
NTDS-CV

CALIBRATE/ALIGN/ADJUST DATA TERMINAL SET

3 2 1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 35%
UYA-4 UYK-7
LHA NTDS-3
NTDS-CV

DS: DISPLAY CONSOLE

CLEAN DISPLAY CONSOLE

3 2 1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 44%
UYA-4 UYK-7
LHA NTDS-3
NTDS-CV

TEST/INSPECT DISPLAY CONSOLE

3 2 1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 33%
UYA-4 UYK-7
LHA NTDS-3
NTDS-CV

LOCALIZE/ISOLATE DISPLAY CONSOLE MALFUNCTION TO THE MODULE/CARD LEVEL

3 2 1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 5%
UYA-4 UYK-7
LHA NTDS-3

LOCALIZE/ISOLATE DISPLAY CONSOLE MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 16%	UYA-4 UYK-7 LHA NTDS-3 NTDS-CV
REMOVE/REPLACE DISPLAY CONSOLE MODULES/CARDS	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 5%	UYA-4 UYK-7 LHA NTDS-3 NTDS-CV
REMOVE/REPLACE DISPLAY CONSOLE COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 22%	UYA-4 UYK-7 LHA NTDS-3 NTDS-CV
CALIBRATE/ALIGN/ADJUST DISPLAY CONSOLE	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 55%	UYA-4 UYK-7 LHA NTDS-3 NTDS-CV

DS: HIGH SPEED PRINTER

CLEAN/LUBRICATE HIGH SPEED PRINTER	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 13%	UYK-5 UYK-20 LHA NTDS-3 NTDS-CV USQ-20
TEST/INSPECT HIGH SPEED PRINTER	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 0%	UYK-5 UYK-20 LHA NTDS-3 NTDS-CV USQ-20
LOCALIZE/ISOLATE HIGH SPEED PRINTER MALFUNCTION TO THE MODULE/CARD LEVEL	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 4%	UYK-5 UYK-20 LHA NTDS-3 NTDS-CV USQ-20
LOCALIZE/ISOLATE HIGH SPEED PRINTER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 4%	UYK-5 UYK-20 LHA NTDS-3 NTDS-CV USQ-20
REMOVE/REPLACE HIGH SPEED PRINTER MODULES/CARDS	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 0%	UYK-5 UYK-20 LHA NTDS-3 NTDS-CV USQ-20

REMOVE/REPLACE HIGH SPEED PRINTER COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 22%
UYK-5 UYK-20
LHA NTDS-3
NTDS-CV USQ-20

CALIBRATE/ALIGN/ADJUST HIGH SPEED PRINTER

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 28%
UYK-5 UYK-20
LHA NTDS-3
NTDS-CV USQ-20

DS: MAGNETIC TAPE CONTROLLER

CLEAN MAGNETIC TAPE CONTROLLER

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING 6%
UYK-5 UYA-4
UYK-20 UYK-7
LHA NTDS-3
NTDS-CV USQ-20

TEST/INSPECT MAGNETIC TAPE CONTROLLER

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 9%
UYK-5 UYA-4
UYK-20 UYK-7
LHA NTDS-3
NTDS-CV USQ-20

LOCALIZE/ISOLATE MAGNETIC TAPE CONTROLLER MALFUNCTION TO THE MODULE/CARD LEVEL

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 19%
UYK-5 UYA-4
UYK-20 UYK-7
LHA NTDS-3
NTDS-CV USQ-20

LOCALIZE/ISOLATE MAGNETIC TAPE CONTROLLER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING 30%
UYK-5 UYA-4
UYK-20 UYK-7
LHA NTDS-3
NTDS-CV USQ-20

REMOVE/REPLACE MAGNETIC TAPE CONTROLLER MODULES/CARDS

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 6%
UYK-5 UYA-4
UYK-20 UYK-7
LHA NTDS-3
NTDS-CV USQ-20

REMOVE/REPLACE MAGNETIC TAPE CONTROLLER COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

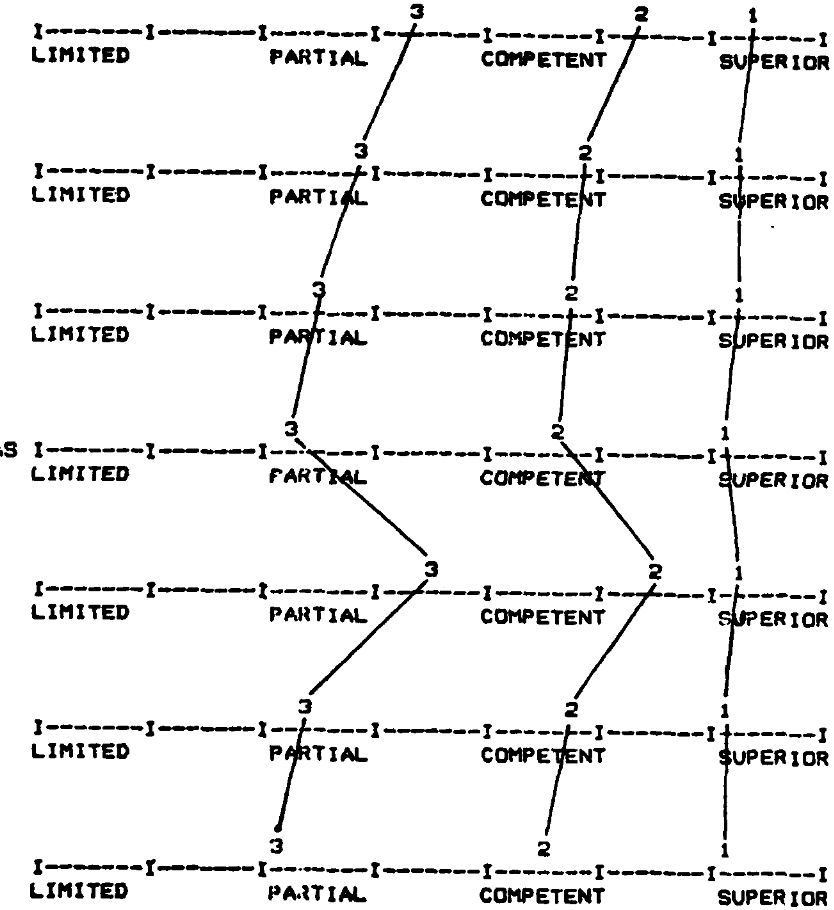
TIME CONSUMING. 29%
UYK-5 UYA-4
UYK-20 UYK-7
LHA NTDS-3
NTDS-CV USQ-20

CALIBRATE/ALIGN/ADJUST MAGNETIC TAFE CONTROLLER

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

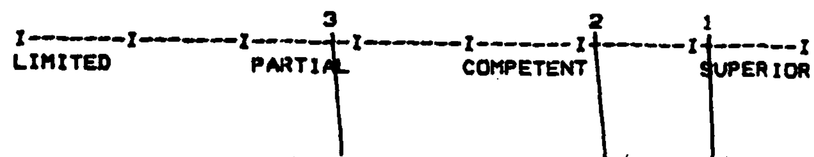
TIME CONSUMING: 23%
UYK-5 UYA-4
UYK-20 UYK-7
LHA NTDS-3

DS: MAGNETIC TAPE TRANSPORT



Task	Time consuming	Systems
CLEAN/LUBRICATE MAGNETIC TAPE TRANSPORT	9%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
TEST/INSPECT MAGNETIC TAPE TRANSPORT	5%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
LOCALIZE/ISOLATE MAGNETIC TAPE TRANSPORT MALFUNCTION TO THE MODULE/CARD LEVEL	9%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
LOCALIZE/ISOLATE MAGNETIC TAPE TRANSPORT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	18%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
REMOVE/REPLACE MAGNETIC TAPE TRANSPORT MODULES/CARDS	11%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
REMOVE/REPLACE MAGNETIC TAPE TRANSPORT COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, ICS, ETC.	30%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
CALIBRATE/ALIGN/ADJUST MAGNETIC TAPE TRANSPORT	34%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20

DS: PAPER TAPE PUNCH

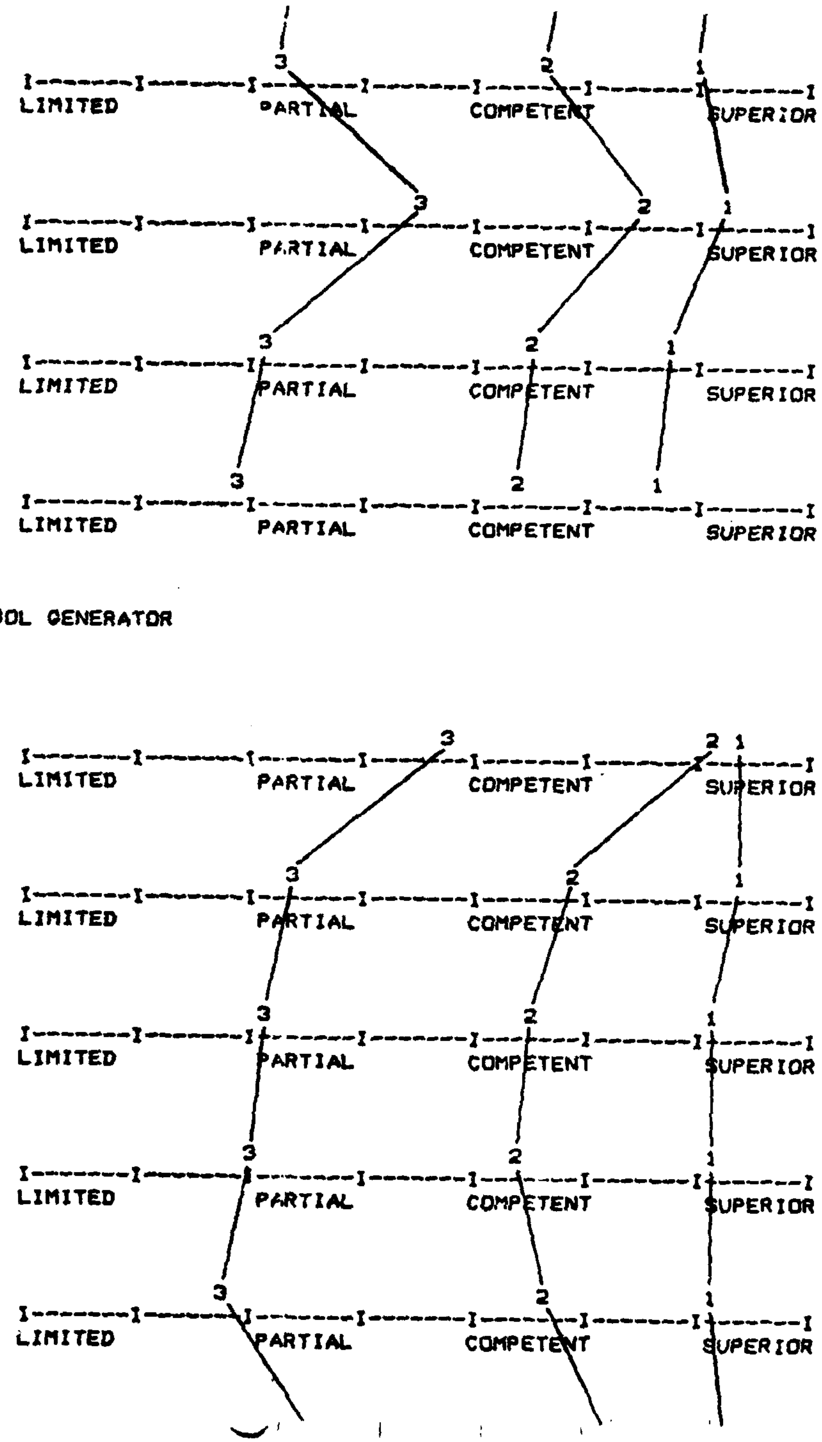


Task	Time consuming	Systems
CLEAN/LUBRICATE PAPER TAPE PUNCH	4%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20

		Time consuming	
TEST/INSPECT PAPER TAPE PUNCH	LIMITED / PARTIAL / COMPETENT / SUPERIOR	0%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
LOCALIZE/ISOLATE PAPER TAPE PUNCH MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED / PARTIAL / COMPETENT / SUPERIOR	8%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
LOCALIZE/ISOLATE PAPER TAPE PUNCH MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED / PARTIAL / COMPETENT / SUPERIOR	17%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
REMOVE/REPLACE PAPER TAPE PUNCH MODULES/CARDS	LIMITED / PARTIAL / COMPETENT / SUPERIOR	8%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
REMOVE/REPLACE PAPER TAPE PUNCH COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED / PARTIAL / COMPETENT / SUPERIOR	19%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USG-20
CALIBRATE/ALIGN/ADJUST PAPER TAPE PUNCH	LIMITED / PARTIAL / COMPETENT / SUPERIOR	30%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USG-20

DS: PAPER TAPE READER

		Time consuming	
CLEAN/LUBRICATE PAPER TAPE READER	LIMITED / PARTIAL / COMPETENT / SUPERIOR	0%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
TEST/INSPECT PAPER TAPE READER	LIMITED / PARTIAL / COMPETENT / SUPERIOR	0%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
LOCALIZE/ISOLATE PAPER TAPE READER MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED / PARTIAL / COMPETENT / SUPERIOR	8%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3



LOCALIZE/ISOLATE PAPER TAPE READER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 8% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
REMOVE/REPLACE PAPER TAPE READER MODULES/CARDS	TIME CONSUMING: 4% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
REMOVE/REPLACE PAPER TAPE READER COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 16% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
CALIBRATE/ALIGN/ADJUST PAPER TAPE READER	TIME CONSUMING: 16% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20

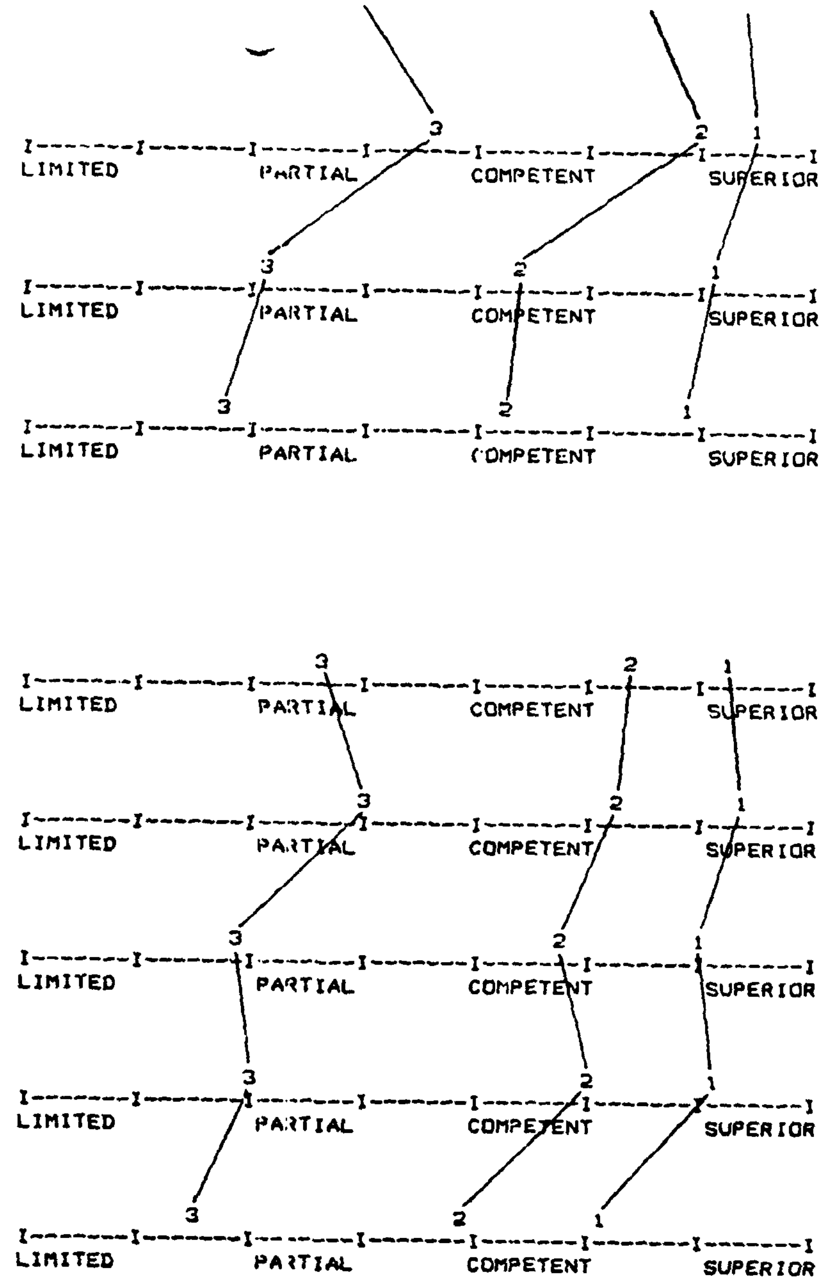
DS: PULSE AMPLIFIER-SYMBOL GENERATOR

CLEAN/LUBRICATE PULSE AMPLIFIER-SYMBOL GENERATOR	TIME CONSUMING: 13% UYA-4 UYK-20 LHA NTDS-3 NTDS-CV
TEST/INSPECT PULSE AMPLIFIER-SYMBOL GENERATOR	TIME CONSUMING: 11% UYA-4 UYK-20 LHA NTDS-3 NTDS-CV
LOCALIZE/ISOLATE PULSE AMPLIFIER-SYMBOL GENERATOR	TIME CONSUMING: 5% UYA-4 UYK-20 LHA NTDS-3 NTDS-CV
LOCALIZE/ISOLATE PULSE AMPLIFIER-SYMBOL GENERATOR MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 0% UYA-4 UYK-20 LHA NTDS-3 NTDS-CV
LOCALIZE/ISOLATE PULSE AMPLIFIER-SYMBOL GENERATOR MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 11% UYA-4 UYK-20 LHA NTDS-3 NTDS-CV

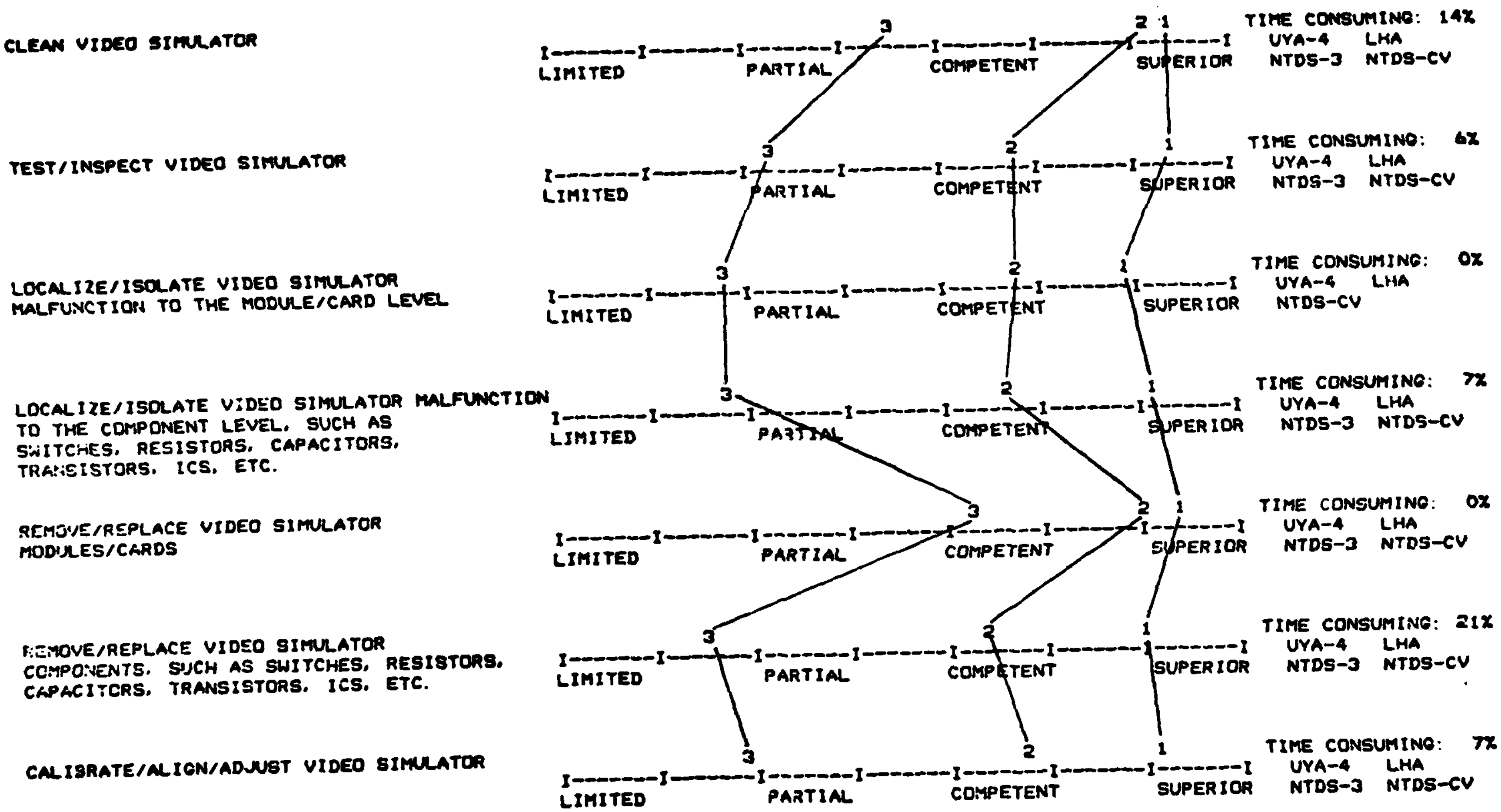
REMOVE/REPLACE PULSE AMPLIFIER-SYMBOL GENERATOR MODULES/CARDS	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING 0% UYA-4 UYK-20 LHA NTDS-3 NTDS-CV
REMOVE/REPLACE PULSE AMPLIFIER-SYMBOL GENERATOR COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING 22% UYA-4 UYK-20 LHA NTDS-3 NTDS-CV
CALIBRATE/ALIGN/ADJUST PULSE AMPLIFIER-SYMBOL GENERATOR	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING 41% UYA-4 LHA NTDS-3 NTDS-CV

DS: TELETYPE

CLEAN/LUBRICATE TELETYPE	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING 5% UYK-5 UYA-4 UYK-20 LHA NTDS-3 NTDS-CV USQ-20
TEST/INSPECT TELETYPE	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING 3% UYK-5 UYA-4 UYK-20 LHA NTDS-3 NTDS-CV USQ-20
LOCALIZE/ISOLATE TELETYPE MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING 19% UYK-5 UYA-4 LHA NTDS-3 NTDS-CV USQ-20
REMOVE/REPLACE TELETYPE COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING 10% UYK-5 UYA-4 LHA NTDS-3 NTDS-CV USQ-20
CALIBRATE/ALIGN/ADJUST TELETYPE	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING 29% UYK-5 UYA-4 LHA NTDS-3 NTDS-CV USQ-20



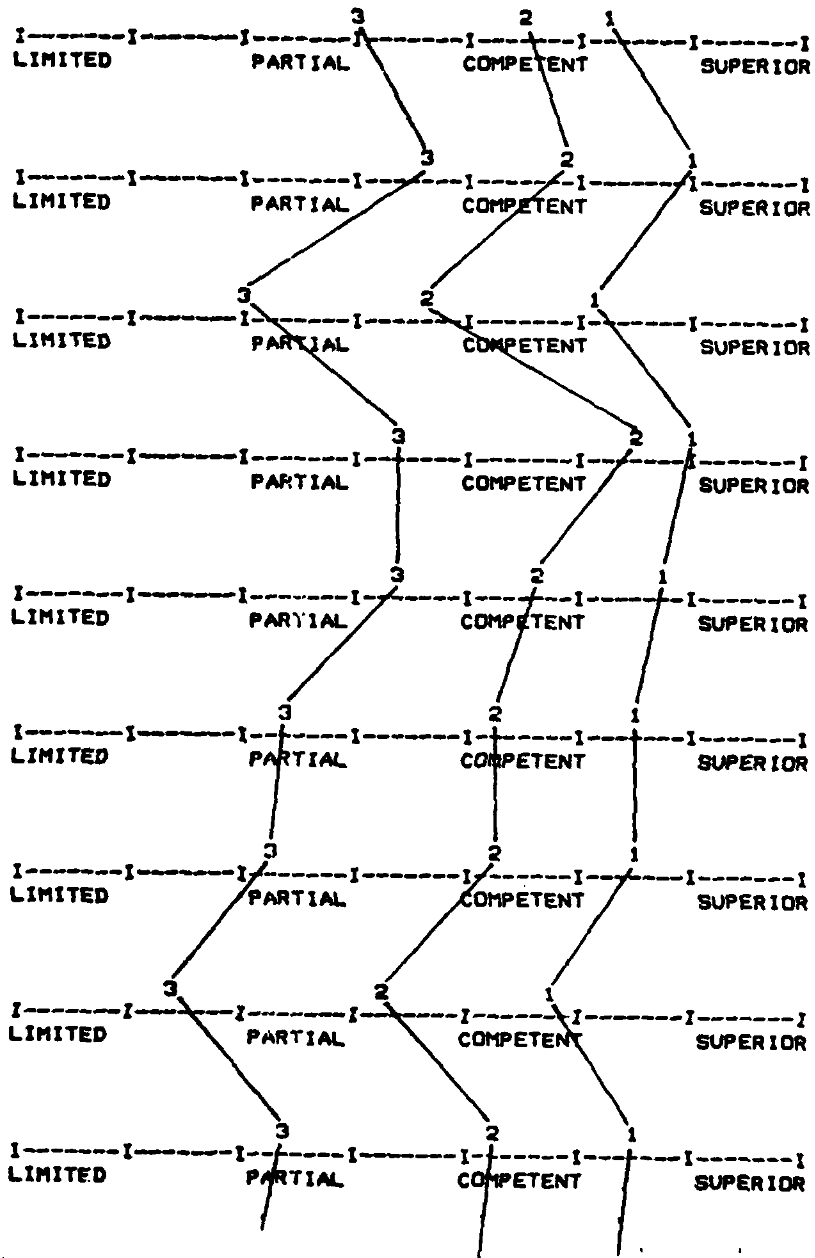
DS: VIDEO SIMULATOR



INDEX OF TASKS PERFORMED BY ET(N)s

ET(N): GENERAL MAINTENANCE

RESEARCH TECHNICAL PUBLICATIONS TO FIND APPROPRIATE SCHEMATICS/LOGIC DIAGRAMS/TABLES/TROUBLESHOOTING CHARTS/ MAINTENANCE INFORMATION/PART NUMBERS FOR SPECIFIC PIECES OF EQUIPMENT	TIME CONSUMING: 28%
IDENTIFY STANDARD ELECTRONIC/ MECHANICAL SYMBOLS AS USED ON SCHEMATICS, LOGIC DIAGRAMS, FLOW CHARTS, ETC.	TIME CONSUMING: 7%
MODIFY EQUIPMENT IN ACCORDANCE WITH SHIPALTS, ORDALTS, FIELD CHANGE ORDERS AND ELECTRONIC INFORMATION BULLETINS (EIBS)	TIME CONSUMING: 25%
CHANGE SYSTEM CONFIGURATION BY PATCHING OR BY SWITCHBOARD CHANGES	TIME CONSUMING: 11%
ANALYZE EQUIPMENT FRONT PANEL INDICATORS FOR FAULT DETECTION	TIME CONSUMING: 0%
USE TEST EQUIPMENT TO INJECT SIGNALS AND/OR TAKE READINGS	TIME CONSUMING: 7%
ASSEMBLE/REPAIR CABLES AND TEST LEADS, SUCH AS CONNECTORS, PROBES, ETC.	TIME CONSUMING: 35%
ALIGN/ADJUST MECHANICAL LINKAGES AND GEAR TRAINS	TIME CONSUMING: 71%
LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A SUBSYSTEM	TIME CONSUMING: 0%



LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A UNIT

3 2 1

I-------I-------I-------I-------I-------I-------I-------I

LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 14%

ET(N): ANTENNA SYSTEMS, COMMUNICATIONS

CLEAN/LUBRICATE COMMUNICATION ANTENNA SYSTEMS

3 2 1

I-------I-------I-------I-------I-------I-------I-------I

LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 14%

TEST/INSPECT COMMUNICATION ANTENNA SYSTEMS

3 2 1

I-------I-------I-------I-------I-------I-------I-------I

LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 0%

LOCALIZE/ISOLATE COMMUNICATION ANTENNA SYSTEMS MALFUNCTION TO A SUBSYSTEM

3 2 1

I-------I-------I-------I-------I-------I-------I-------I

LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 14%

LOCALIZE/ISOLATE COMMUNICATION ANTENNA SYSTEMS MALFUNCTION TO A UNIT

3 2 1

I-------I-------I-------I-------I-------I-------I-------I

LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 14%

LOCALIZE/ISOLATE COMMUNICATION ANTENNA SYSTEMS MALFUNCTION TO THE COMPONENT LEVEL

3 2 1

I-------I-------I-------I-------I-------I-------I-------I

LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 14%

REMOVE/REPLACE COMMUNICATION ANTENNA SYSTEMS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS TRANSISTORS, ICS, ETC.

* 3 1 2 *

I-------I-------I-------I-------I-------I-------I-------I

LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 33%

CALIBRATE/ALIGN/ADJUST COMMUNICATION ANTENNA SYSTEMS

* 3 2 1 *

I-------I-------I-------I-------I-------I-------I-------I

LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 60%

ET(N): AUDIO

LOCALIZE/ISOLATE AUDIO MALFUNCTION TO A UNIT — TIME CONSUMING: 0%

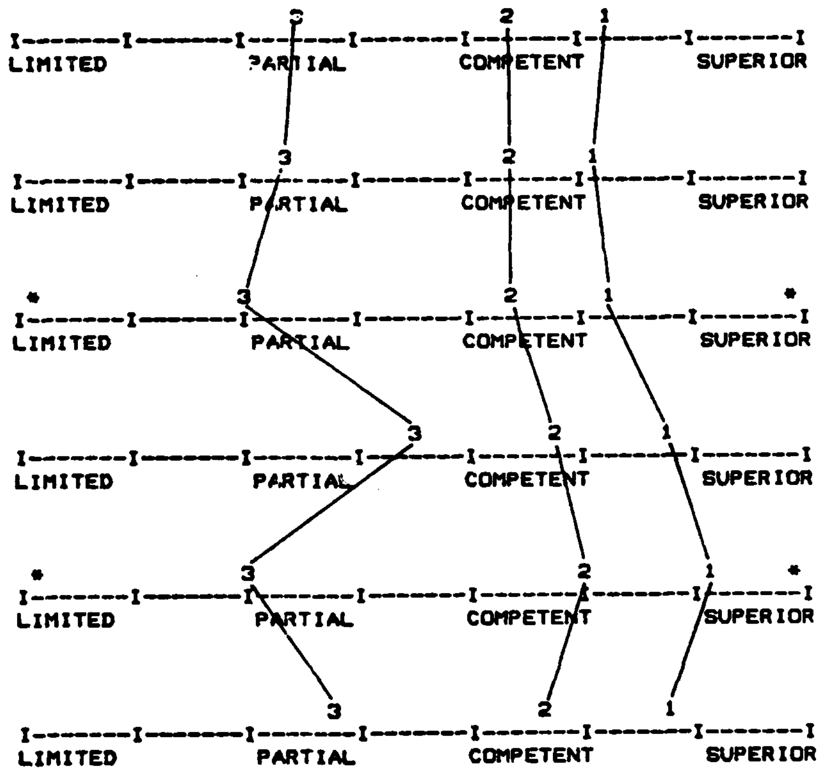
LOCALIZE/ISOLATE AUDIO MALFUNCTION TO THE MODULE/CARD LEVEL — TIME CONSUMING: 0%

LOCALIZE/ISOLATE AUDIO MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — TIME CONSUMING: 0%

REMOVE/REPLACE AUDIO MODULES/CARDS — TIME CONSUMING: 0%

REMOVE/REPLACE AUDIO COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — TIME CONSUMING: 0%

CALIBRATE/ALIGN/ADJUST AUDIO — TIME CONSUMING: 0%



ET(N): COMMUNICATION EQUIPMENT, VHF/UHF

TEST/INSPECT VHF/UHF COMMUNICATION EQUIPMENT

INSUFFICIENT DATA TO DERIVE SCALE VALUES

I--------I--------I--------I--------I--------I--------I--------I

LIMITED PARTIAL COMPETENT SUPERIOR

LOCALIZE/ISOLATE VHF/UHF COMMUNICATION EQUIPMENT MALFUNCTION A UNIT

INSUFFICIENT DATA TO DERIVE SCALE VALUES

I--------I--------I--------I--------I--------I--------I--------I

LIMITED PARTIAL COMPETENT SUPERIOR

LOCALIZE/ISOLATE VHF/UHF COMMUNICATION EQUIPMENT MALFUNCTION TO THE MODULE/CARD LEVEL

INSUFFICIENT DATA TO DERIVE SCALE VALUES
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

LOCALIZE/ISOLATE VHF/UHF COMMUNICATION EQUIPMENT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

INSUFFICIENT DATA TO DERIVE SCALE VALUES
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

REMOVE/REPLACE VHF/UHF COMMUNICATION EQUIPMENT

INSUFFICIENT DATA TO DERIVE SCALE VALUES
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

REMOVE/REPLACE VHF/UHF COMMUNICATION EQUIPMENT COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

INSUFFICIENT DATA TO DERIVE SCALE VALUES
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

CALIBRATE/ALIGN/ADJUST VHF/UHF COMMUNICATION EQUIPMENT

INSUFFICIENT DATA TO DERIVE SCALE VALUES
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

ET(N): COMMUNICATION PATCHING FACILITY

TEST/INSPECT COMM PATCHING FACILITY

* 3 2 1 * TIME CONSUMING: 0%
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

LOCALIZE/ISOLATE COMM PATCHING FACILITY MALFUNCTION TO A UNIT

* 3 1 2 * TIME CONSUMING: 20%
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

LOCALIZE/ISOLATE COMM PATCHING FACILITY MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

* 3 2 1 * TIME CONSUMING: 40%
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

REMOVE/REPLACE COMM PATCHING FACILITY COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC

* 3 2 1 * TIME CONSUMING: 20%
I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

CALIBRATE/ALIGN/ADJUST COMM PATCHING FACILITY

3 2 1

LIMITED PARTIAL COMPETENT SUPERIOR * TIME CONSUMING: 20%

ET(N): COMMUNICATION REMOTES

TEST/INSPECT COMMUNICATION REMOTES

3 2 1

LIMITED PARTIAL COMPETENT SUPERIOR * TIME CONSUMING: 0%

LOCALIZE/ISOLATE COMMUNICATION REMOTES MALFUNCTION TO A UNIT

3 2 1

LIMITED PARTIAL COMPETENT SUPERIOR * TIME CONSUMING: 0%

LOCALIZE/ISOLATE COMMUNICATION REMOTES MALFUNCTION TO THE MODULE/ CARD LEVEL

3 2 1

LIMITED PARTIAL COMPETENT SUPERIOR * TIME CONSUMING: 0%

LOCALIZE/ISOLATE COMMUNICATION REMOTES MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

3 12

LIMITED PARTIAL COMPETENT SUPERIOR * TIME CONSUMING: 20%

REMOVE/REPLACE COMMUNICATION REMOTES MODULES/CARDS

3 21

LIMITED PARTIAL COMPETENT SUPERIOR * TIME CONSUMING: 0%

REMOVE/REPLACE COMMUNICATION REMOTES COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

3 2 1

LIMITED PARTIAL COMPETENT SUPERIOR * TIME CONSUMING: 20%

CALIBRATE/ALIGN/ADJUST COMMUNICATION REMOTES

3 2 1

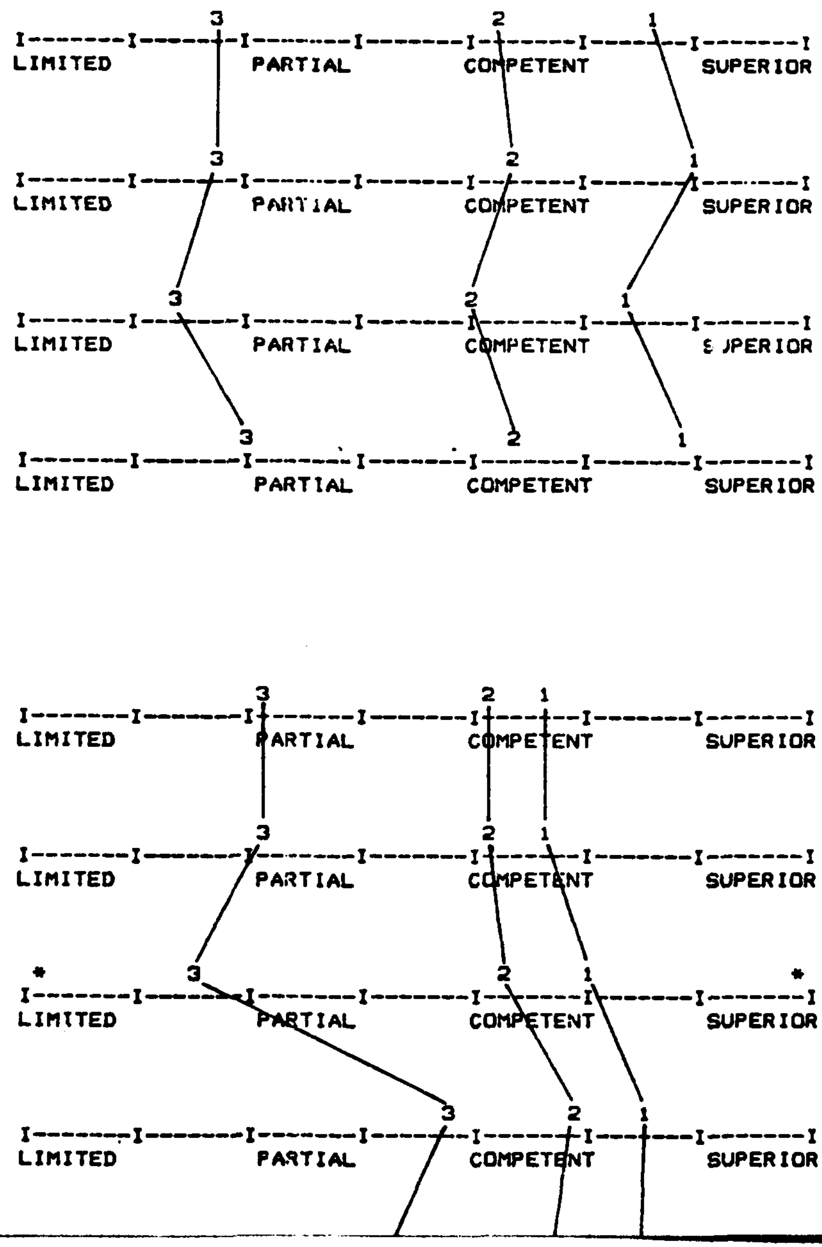
LIMITED PARTIAL COMPETENT SUPERIOR * TIME CONSUMING: 0%

ET(N): COOLING SYSTEMS

TEST/INSPECT ELECTRONIC EQUIPMENT COOLING SYSTEM	TIME CONSUMING: 22%
LOCALIZE/ISOLATE ELECTRONIC EQUIPMENT COOLING SYSTEM MALFUNCTION TO A UNIT	TIME CONSUMING: 11%
LOCALIZE/ISOLATE ELECTRONIC EQUIPMENT COOLING SYSTEM MALFUNCTION TO THE FAILED PART	TIME CONSUMING: 37%
REMOVE/REPLACE ELECTRONIC EQUIPMENT COOLING SYSTEM FAILED PART	TIME CONSUMING: 37%

ET(N): DEMODULATION

LOCALIZE/ISOLATE DEMODULATION MALFUNCTION TO A UNIT	TIME CONSUMING: 14%
LOCALIZE/ISOLATE DEMODULATION MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 14%
LOCALIZE/ISOLATE DEMODULATION MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 20%
REMOVE/REPLACE DEMODULATION MODULES/CARDS	TIME CONSUMING: 0%



```
REMOVE/REPLACE DEMODULATION COM-          *                  3              2     1        *    TIME CONSUMING:  0%
PONENTS. SUCH AS SWITCHES,                I-------I-------I-------I-------I-------I-------I-------I
RESISTORS, CAPACITORS, TRANSISTORS,       LIMITED         PARTIAL         COMPETENT       SUPERIOR
ICS, ETC.

CALIBRATE/ALIGN/ADJUST DEMODULATION                      3               2    1                  TIME CONSUMING: 42%
                                          I-------I-------I-------I-------I-------I-------I-------I
                                          LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

ET(N): HEADSETS/HANDSETS

```
TEST/INSPECT HEADSETS/HANDSETS                                            3       21                TIME CONSUMING:  0%
                                          I-------I-------I-------I-------I-------I-------I-------I
                                          LIMITED         PARTIAL         COMPETENT       SUPERIOR

LOCALIZE/ISOLATE HEADSETS/                                                3       21                TIME CONSUMING:  0%
HANDSETS MALFUNCTION TO THE               I-------I-------I-------I-------I-------I-------I-------I
COMPONENT LEVEL, SUCH AS SWITCHES,        LIMITED         PARTIAL         COMPETENT       SUPERIOR
RESISTORS, CAPACITORS, TRANSISTORS,
ICS, ETC.

REMOVE/REPLACE HEADSETS/HANDSETS                                          3       21                TIME CONSUMING:  0%
COMPONENTS, SUCH AS SWITCHES,             I-------I-------I-------I-------I-------I-------I-------I
RESISTORS, CAPACITORS, TRANSISTORS,       LIMITED         PARTIAL         COMPETENT       SUPERIOR
ICS, ETC.
```

ET(N): IF UNITS

```
LOCALIZE/ISOLATE IF MALFUNCTION                          3               2       1                 TIME CONSUMING: 12%
TO A UNIT                                 I-------I-------I-------I-------I-------I-------I-------I
                                          LIMITED         PARTIAL         COMPETENT       SUPERIOR

LOCALIZE/ISOLATE IF MALFUNCTION                   3               2          1                     TIME CONSUMING: 14%
TO THE MODULE/CARD LEVEL                  I-------I-------I-------I-------I-------I-------I-------I
                                          LIMITED         PARTIAL         COMPETENT       SUPERIOR

LOCALIZE/ISOLATE IF MALFUNCTION TO              3               2            1                     TIME CONSUMING: 16%
THE COMPONENT LEVEL, SUCH AS              I-------I-------I-------I-------I-------I-------I-------I
SWITCHES, RESISTORS, CAPACITORS,          LIMITED         PARTIAL         COMPETENT       SUPERIOR
TRANSISTORS, ICS, ETC.
```

REMOVE/REPLACE IF MODULES/CARDS — TIME CONSUMING: 14%

REMOVE/REPLACE IF COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — TIME CONSUMING: 33%

CALIBRATE/ALIGN/ADJUST IF — TIME CONSUMING: 37%

ET(N): MIXERS

LOCALIZE/ISOLATE MIXERS (FREQ TRANSLATION) MALFUNCTION TO A UNIT — TIME CONSUMING: 16%

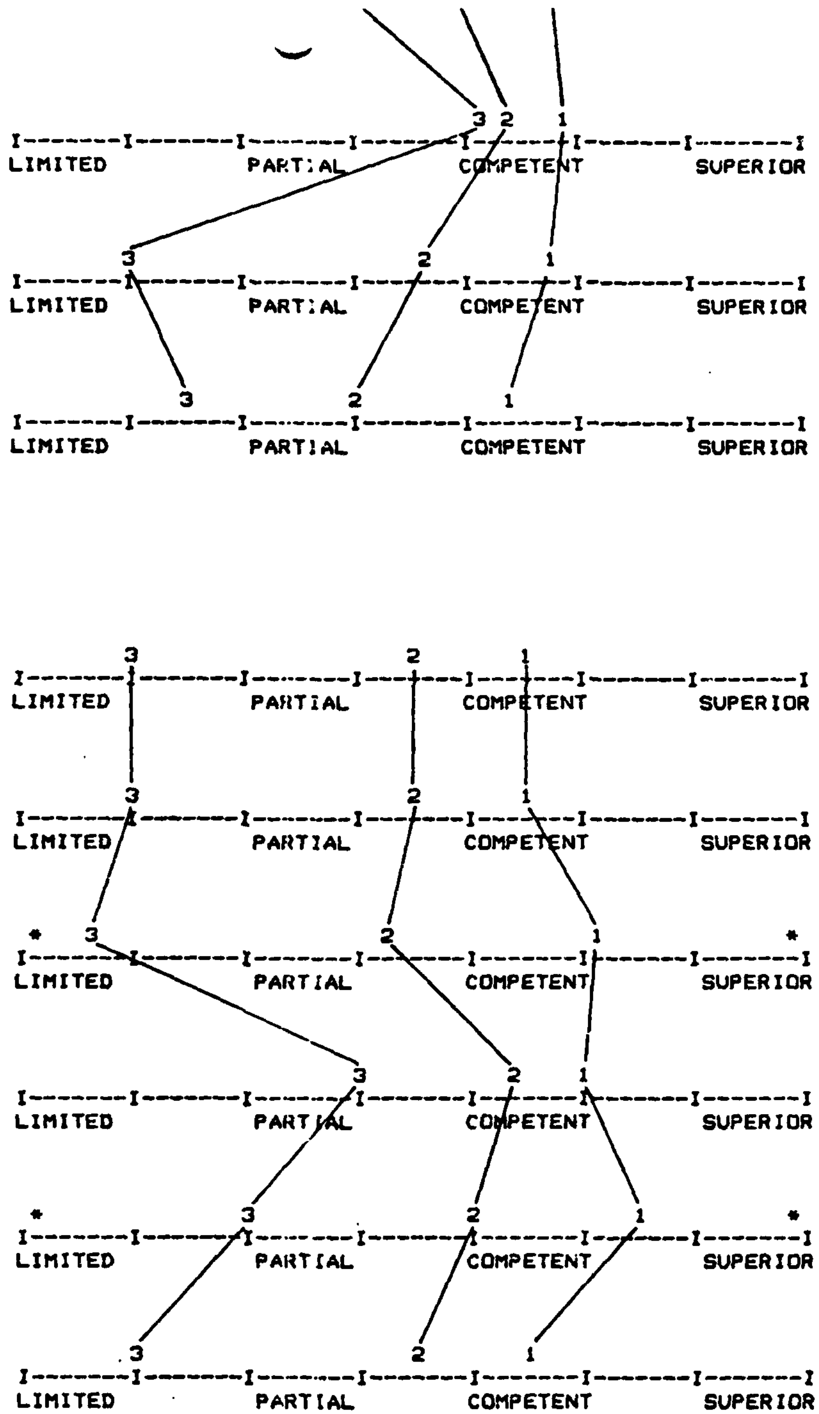
LOCALIZE/ISOLATE MIXERS (FREQ TRANSLATION) MALFUNCTION TO THE MODULE/CARD LEVEL — TIME CONSUMING: 16%

LOCALIZE/ISOLATE MIXERS (FREQ TRANSLATION) MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — * * TIME CONSUMING: 20%

REMOVE/REPLACE MIXERS (FREQ TRANSLATION) MODULES/CARDS — TIME CONSUMING: 0%

REMOVE/REPLACE MIXERS (FREQ TRANSLATION) COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — * * TIME CONSUMING: 0%

CALIBRATE/ALIGN/ADJUST MIXERS (FREQ TRANSLATION) — TIME CONSUMING: 66%



ET(N): MODULATION

LOCALIZE/ISOLATE MODULATION MALFUNCTION TO A UNIT

```
                  3         2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 0%

LOCALIZE/ISOLATE MODULATION MALFUNCTION TO THE MODULE/CARD LEVEL

```
                  3         2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 0%

LOCALIZE/ISOLATE MODULATION MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

```
 *              3           2  1                        *
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 0%

REMOVE/REPLACE MODULATION MODULES/CARDS

```
                                3     2       1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 0%

REMOVE/REPLACE MODULATION COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

```
 *              3           2      1                    *
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 0%

CALIBRATE/ALIGN/ADJUST MODULATION

```
               3            2   1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 14%

ET(N): MOTOR GENERATORS

CLEAN/LUBRICATE MOTOR/GENERATORS

```
                   3       2           1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 0%

TEST/INSPECT MOTOR/GENERATORS

```
                 3         2           1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TIME CONSUMING: 0%

		Time consuming
LOCALIZE/ISOLATE MOTOR/GENERATORS	LIMITED PARTIAL COMPETENT SUPERIOR	0%
[illegible] MOTOR/GENERATORS [illegible] TO THE FAILED PART	LIMITED PARTIAL COMPETENT SUPERIOR	16%
REMOVE/REPLACE MOTOR/GENERATORS FAILED PART	LIMITED PARTIAL COMPETENT SUPERIOR	16%

ET(N): RECEIVERS, VLF/LF/HF

		Time consuming
TEST/INSPECT VLF/LF/HF RECEIVERS	LIMITED PARTIAL COMPETENT SUPERIOR	20%
LOCALIZE/ISOLATE VLF/LF/HF RECEIVERS MALFUNCTION TO A UNIT	LIMITED PARTIAL COMPETENT SUPERIOR	0%
LOCALIZE/ISOLATE VLF/LF/HF RECEIVERS MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED PARTIAL COMPETENT SUPERIOR	0%
LOCALIZE/ISOLATE VLF/LF/HF RECEIVERS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED PARTIAL COMPETENT SUPERIOR	20%
REMOVE/REPLACE VLF/LF/HF RECEIVERS MODULES/CARDS	LIMITED PARTIAL COMPETENT SUPERIOR	20%
REMOVE/REPLACE VLF/LF/HF RECEIVERS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS,	LIMITED PARTIAL COMPETENT SUPERIOR	20%

CALIBRATE/ALIGN/ADJUST VLF/LF/HF RECEIVERS

```
 *          3                 2         1               *   TIME CONSUMING: 40%
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

ET(N): RF UNITS

LOCALIZE/ISOLATE RF MALFUNCTION TO A UNIT

```
                  3              2      1                   TIME CONSUMING: 14%
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

LOCALIZE/ISOLATE RF MALFUNCTION TO THE MODULE/CARD LEVEL

```
              3                  2      1                   TIME CONSUMING:  0%
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

LOCALIZE/ISOLATE RF MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

```
 *     3                     2          1               *   TIME CONSUMING:  0%
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

REMOVE/REPLACE RF MODULES CARDS

```
                        3             2  1                  TIME CONSUMING:  0%
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

REMOVE/REPLACE RF COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

```
 *                 3                 2       1          *   TIME CONSUMING: 20%
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

CALIBRATE/ALIGN/ADJUST RF

```
                  3           2         1                   TIME CONSUMING: 28%
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

ET(N): SECURE EQUIPMENT

LOCALIZE/ISOLATE SECURE EQUIPMENT SYSTEMS MALFUNCTION TO A SUBSYSTEM

```
        INSUFFICIENT DATA TO DERIVE SCALE VALUES
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

Task	LIMITED — PARTIAL — COMPETENT — SUPERIOR	
LOCALIZE/ISOLATE SECURE EQUIPMENT SYSTEMS MALFUNCTION TO A UNIT	INSUFFICIENT DATA TO DERIVE SCALE VALUES	
LOCALIZE/ISOLATE SECURE EQUIPMENT SYSTEMS MALFUNCTION TO THE MODULE/CARD LEVEL	INSUFFICIENT DATA TO DERIVE SCALE VALUES	
LOCALIZE/ISOLATE SECURE EQUIPMENT SYSTEMS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	INSUFFICIENT DATA TO DERIVE SCALE VALUES	
REMOVE/REPLACE SECURE EQUIPMENT SYSTEMS MODULES/CARDS	INSUFFICIENT DATA TO DERIVE SCALE VALUES	
REMOVE/REPLACE SECURE EQUIPMENT SYSTEMS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	INSUFFICIENT DATA TO DERIVE SCALE VALUES	
CALIBRATE/ALIGN/ADJUST SECURE EQUIPMENT SYSTEMS	INSUFFICIENT DATA TO DERIVE SCALE VALUES	

ET(N): SYNCHRO/SERVO AMPLIFIERS

Task	LIMITED — PARTIAL — COMPETENT — SUPERIOR	
TEST/INSPECT SYNCHRO/SERVO AMPLIFIERS	* 3 2 1 *	TIME CONSUMING: 20%
LOCALIZE/ISOLATE SYNCHRO/SERVO AMPLIFIERS MALFUNCTION TO THE MODULE/CARD LEVEL	3 2 1	TIME CONSUMING: 14%
LOCALIZE/ISOLATE SYNCHRO/SERVO AMPLIFIERS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	* 3 2 1 *	TIME CONSUMING: 16%

REMOVE/REPLACE SYNCHRO/SERVO AMPLIFIERS MODULES/CARDS — TIME CONSUMING: 14%

REMOVE/REPLACE SYNCHRO/SERVO AMPLIFIERS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — * TIME CONSUMING: 16%

CALIBRATE/ALIGN/ADJUST SYNCHRO/SERVO AMPLIFIERS — TIME CONSUMING: 42%

ET(N): TEST EQUIPMENT

CLEAN/LUBRICATE TEST EQUIPMENT — TIME CONSUMING: 0%

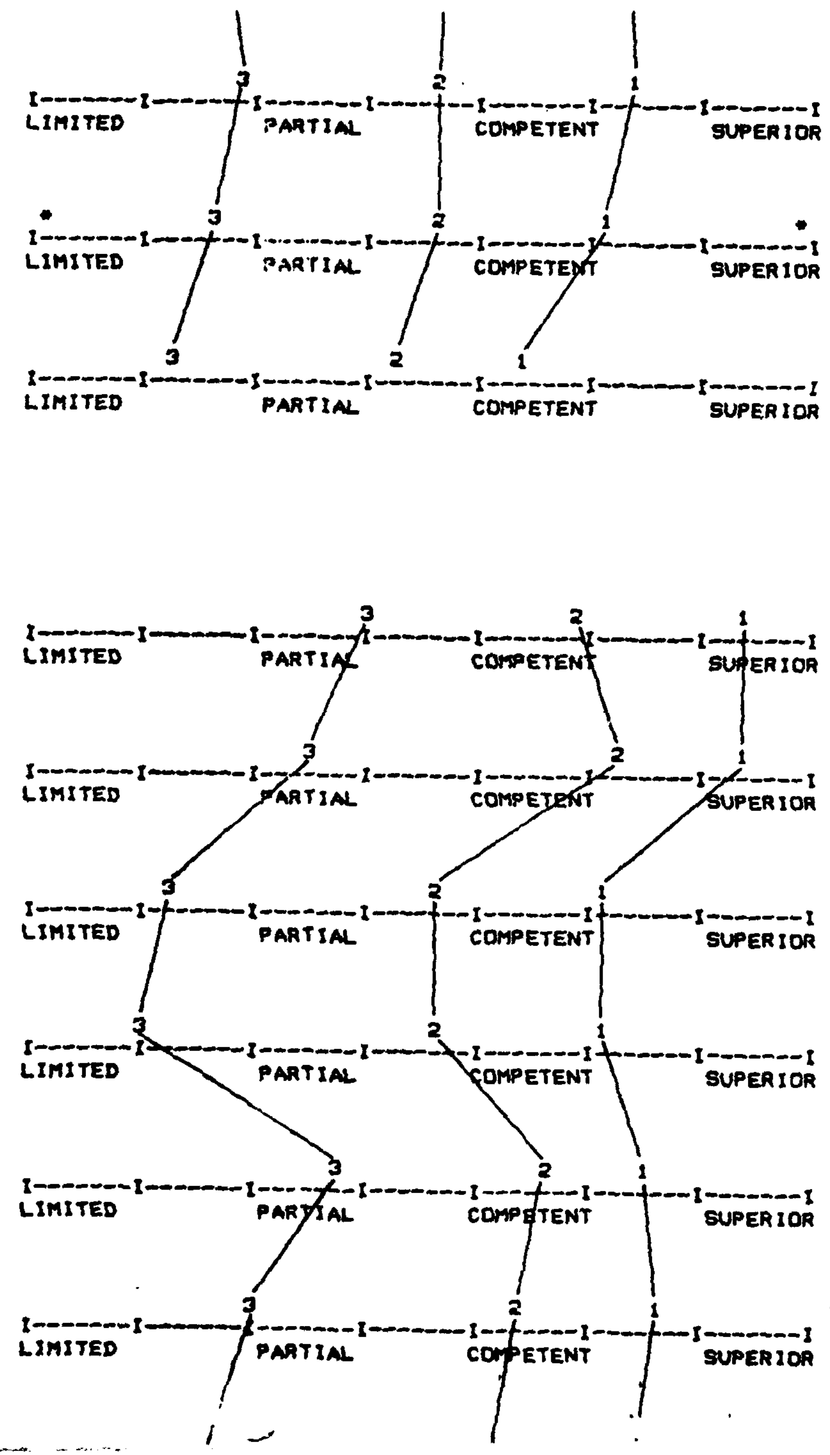
TEST/INSPECT TEST EQUIPMENT — TIME CONSUMING: 10%

LOCALIZE/ISOLATE TEST EQUIPMENT MALFUNCTION TO THE MODULE/CARD LEVEL — TIME CONSUMING: 0%

LOCALIZE/ISOLATE TEST EQUIPMENT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — TIME CONSUMING: 0%

REMOVE/REPLACE TEST EQUIPMENT MODULES/CARDS — TIME CONSUMING: 0%

REMOVE/REPLACE TEST EQUIPMENT COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — TIME CONSUMING: 10%



CALIBRATE/ALIGN/ADJUST TEST EQUIPMENT — TIME CONSUMING: 50%

ET(N): TRANSMITTERS, VLF/LF/HF

TEST/INSPECT VLF/LF/HF TRANSMITTERS — TIME CONSUMING: 0%

LOCALIZE/ISOLATE VLF/LF/HF TRANASMITTERS MALFUNCTION TO A UNIT — TIME CONSUMING: 0%

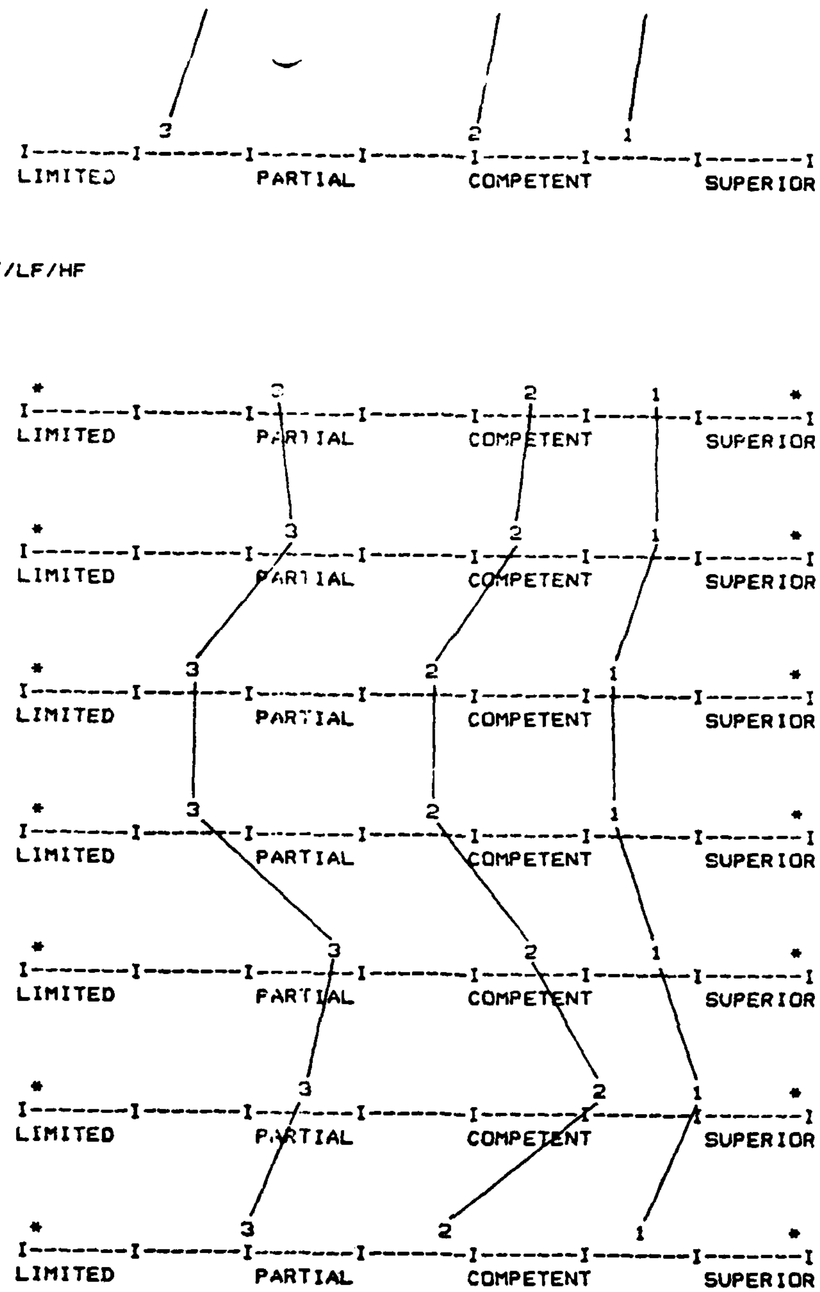
LOCALIZE/ISOLATE VLF/LF/HF TRANSMITTERS MALFUNCTION TO THE MODULE/CARD LEVEL — TIME CONSUMING: 40%

LOCALIZE/ISOLATE VLF/LF/HF TRANSMITTERS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC — TIME CONSUMING: 40%

REMOVE/REPLACE VLF/LF/HF TRANSMITTERS MODULES/CARDS — TIME CONSUMING: 0%

REMOVE/REPLACE VLF/LF/HF TRANSMITTERS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC — TIME CONSUMING: 20%

CALIBRATE/ALIGN/ADJUST VLF/LF/HF TRANSMITTERS — TIME CONSUMING: 60%

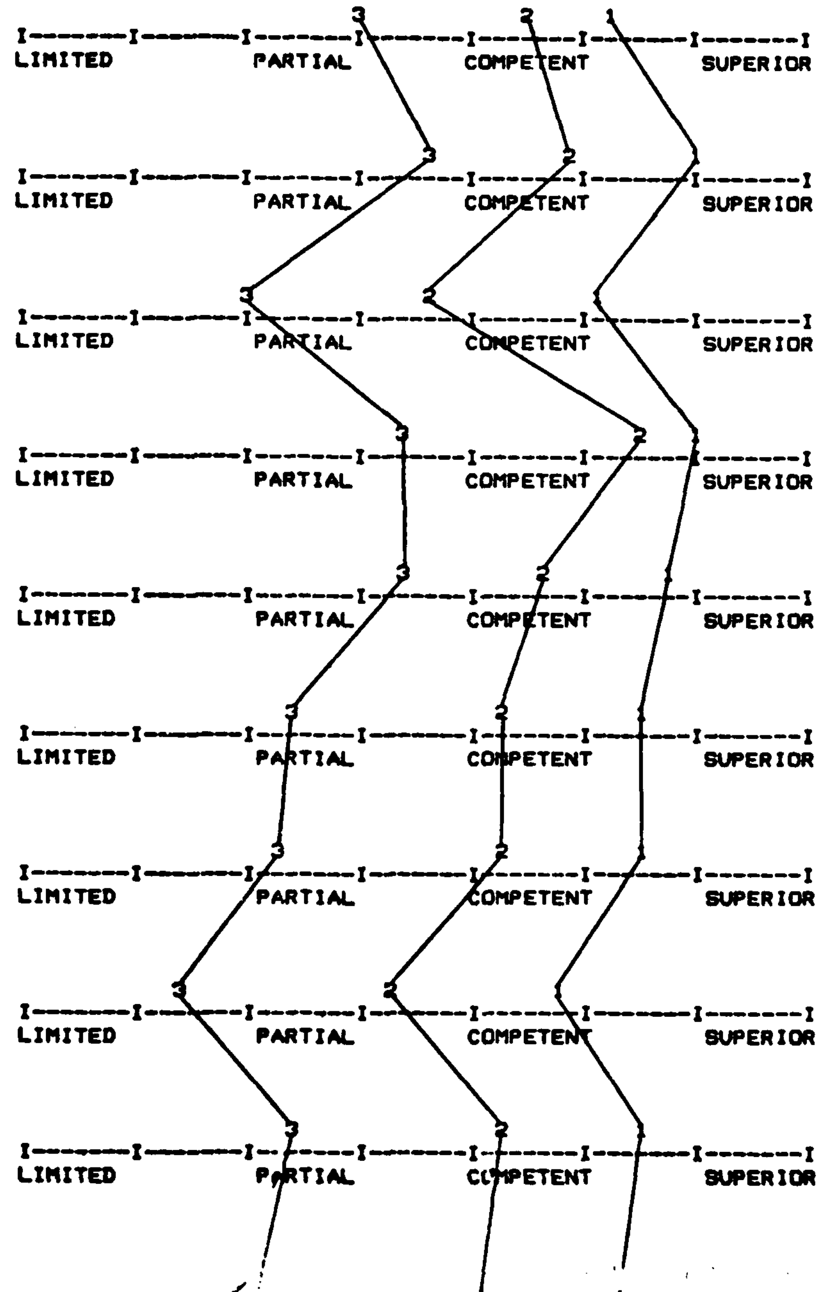


ET(N): TTY COMPARATOR CONVERTER

TEST/INSPECT TTY COMPARATOR CONVERTER GROUP	INSUFFICIENT DATA TO DERIVE SCALE VALUES I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR
LOCALIZE/ISOLATE TTY COMPARATOR CONVERTER GROUP MALFUNCTION TO THE MODULE/CARD LEVEL	INSUFFICIENT DATA TO DERIVE SCALE VALUES I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR
LOCALIZE/ISOLATE TTY COMPARATOR CONVERTER GROUP MALFUNCTION TO THE COMPONENT LEVEL	INSUFFICIENT DATA TO DERIVE SCALE VALUES I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR
REMOVE/REPLACE TTY COMPARATOR CONVERTER GROUP COMPONENTS	INSUFFICIENT DATA TO DERIVE SCALE VALUES I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR
CALIBRATE/ALIGN/ADJUST TTY COMPARATOR CONVERTER GROUP	INSUFFICIENT DATA TO DERIVE SCALE VALUES I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR

INDEX OF TASKS PERFORMED BY ET(R)s

Task	Time Consuming
RESEARCH TECHNICAL PUBLICATIONS TO FIND APPROPRIATE SCHEMATICS/LOGIC DIAGRAMS/TABLES/TROUBLESHOOTING CHARTS/ MAINTENANCE INFORMATION/PART NUMBERS FOR SPECIFIC PIECES OF EQUIPMENT	28%
IDENTIFY STANDARD ELECTRONIC/ MECHANICAL SYMBOLS AS USED ON SCHEMATICS, LOGIC DIAGRAMS, FLOW CHARTS, ETC.	7%
MODIFY EQUIPMENT IN ACCORDANCE WITH SHIPALTS, ORDALTS, FIELD CHANGE ORDERS AND ELECTRONIC INFORMATION BULLETINS (EIBS)	25%
CHANGE SYSTEM CONFIGURATION BY PATCHING OR BY SWITCHBOARD CHANGES	11%
ANALYZE EQUIPMENT FRONT PANEL INDICATORS FOR FAULT DETECTION	0%
USE TEST EQUIPMENT TO INJECT SIGNALS AND/OR TAKE READINGS	7%
ASSEMBLE/REPAIR CABLES AND TEST LEADS, SUCH AS CONNECTORS, PROBES, ETC.	35%
ALIGN/ADJUST MECHANICAL LINKAGES AND GEAR TRAINS	71%
LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A SUBSYSTEM	0%



LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A UNIT	3 near PARTIAL, 2 near COMPETENT, 1 between COMPETENT and SUPERIOR — LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 14%

ET(R): COOLING SYSTEMS

TEST/INSPECT ELECTRONIC EQUIPMENT COOLING SYSTEM	3, 2, 1 — LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 22%
LOCALIZE/ISOLATE ELECTRONIC EQUIPMENT COOLING SYSTEM MALFUNCTION TO A UNIT	3, 2, 1 — LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 11%
LOCALIZE/ISOLATE ELECTRONIC EQUIPMENT COOLING SYSTEM MALFUNCTION TO THE FAILED PART	3, 2, 1 — LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 37%
REMOVE/REPLACE ELECTRONIC EQUIPMENT COOLING SYSTEM FAILED PART	3, 2, 1 — LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 37%

ET(R): IFF SYSTEM

TEST/INSPECT IFF SYSTEM	INSUFFICIENT DATA TO DERIVE SCALE VALUES — LIMITED / PARTIAL / COMPETENT / SUPERIOR
LOCALIZE/ISOLATE IFF SYSTEM MALFUNCTION TO A SUBSYSTEM	INSUFFICIENT DATA TO DERIVE SCALE VALUES — LIMITED / PARTIAL / COMPETENT / SUPERIOR
LOCALIZE/ISOLATE IFF SYSTEM MALFUNCTION TO A UNIT	INSUFFICIENT DATA TO DERIVE SCALE VALUES — LIMITED / PARTIAL / COMPETENT / SUPERIOR

LOCALIZE/ISOLATE IFF SYSTEM MAL-FUNCTION TO THE MODULE/CARD LEVEL

INSUFFICIENT DATA TO DERIVE SCALE VALUES
```
I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

LOCALIZE/ISOLATE IFF SYSTEM MAL-FUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

INSUFFICIENT DATA TO DERIVE SCALE VALUES
```
I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

REMOVE/REPLACE IFF SYSTEM MODULES/CARDS

INSUFFICIENT DATA TO DERIVE SCALE VALUES
```
I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

REMOVE/REPLACE IFF SYSTEM COM-PONENTS, SUCH AS SWITCHES, RE-SISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

INSUFFICIENT DATA TO DERIVE SCALE VALUES
```
I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

CALIBRATE/ALIGN/ADJUST IFF SYSTEM

INSUFFICIENT DATA TO DERIVE SCALE VALUES
```
I-------I-------I-------I-------I-------I-------I
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

ET(R): MOTOR GENERATORS

CLEAN/LUBRICATE MOTOR/GENERATORS
```
                       3         2        1
I-------I-------I-------I-------I-------I-------I   TIME CONSUMING:  0%
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

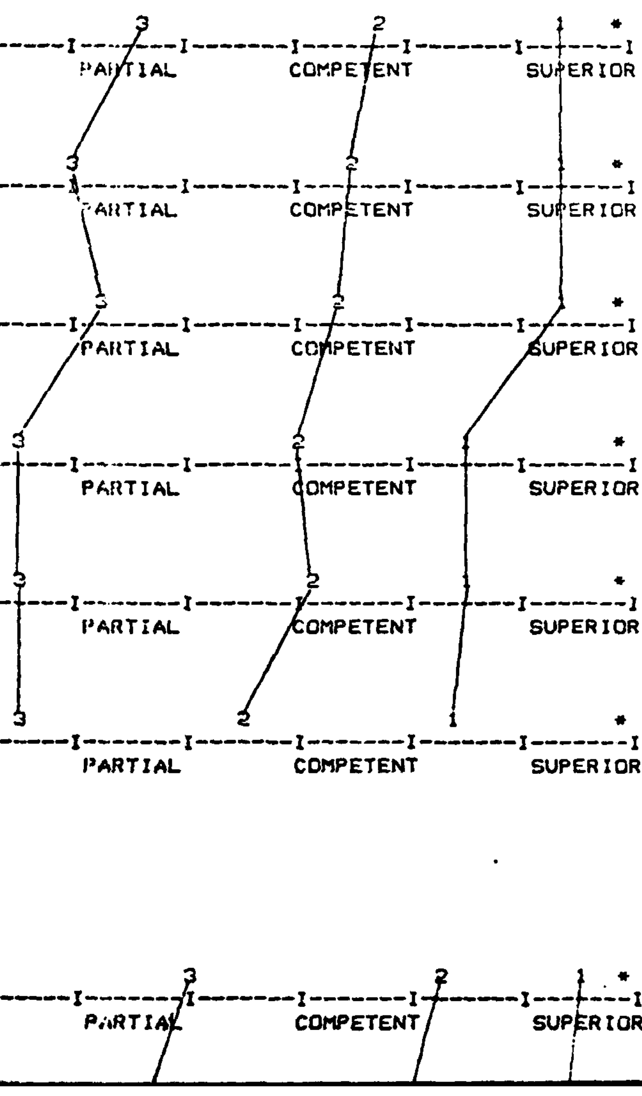
TEST/INSPECT MOTOR/GENERATORS
```
                      3          2        1
I-------I-------I-------I-------I-------I-------I   TIME CONSUMING:  0%
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

LOCALIZE/ISOLATE MOTOR/GENERATORS
```
                   3             2        1
I-------I-------I-------I-------I-------I-------I   TIME CONSUMING:  0%
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

LOCALIZE/ISOLATE MOTOR/GENERATORS MALFUNCTION TO THE FAILED PART
```
*               3                   2        1            *
I-------I-------I-------I-------I-------I-------I   TIME CONSUMING: 16%
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

```
REMOVE/REPLACE MOTOR/GENERATORS        *              3          2       1        *  TIME CONSUMING  16%
FAILED PART                            I-------I-------I-------I-------I-------I-------I-------I
                                       LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

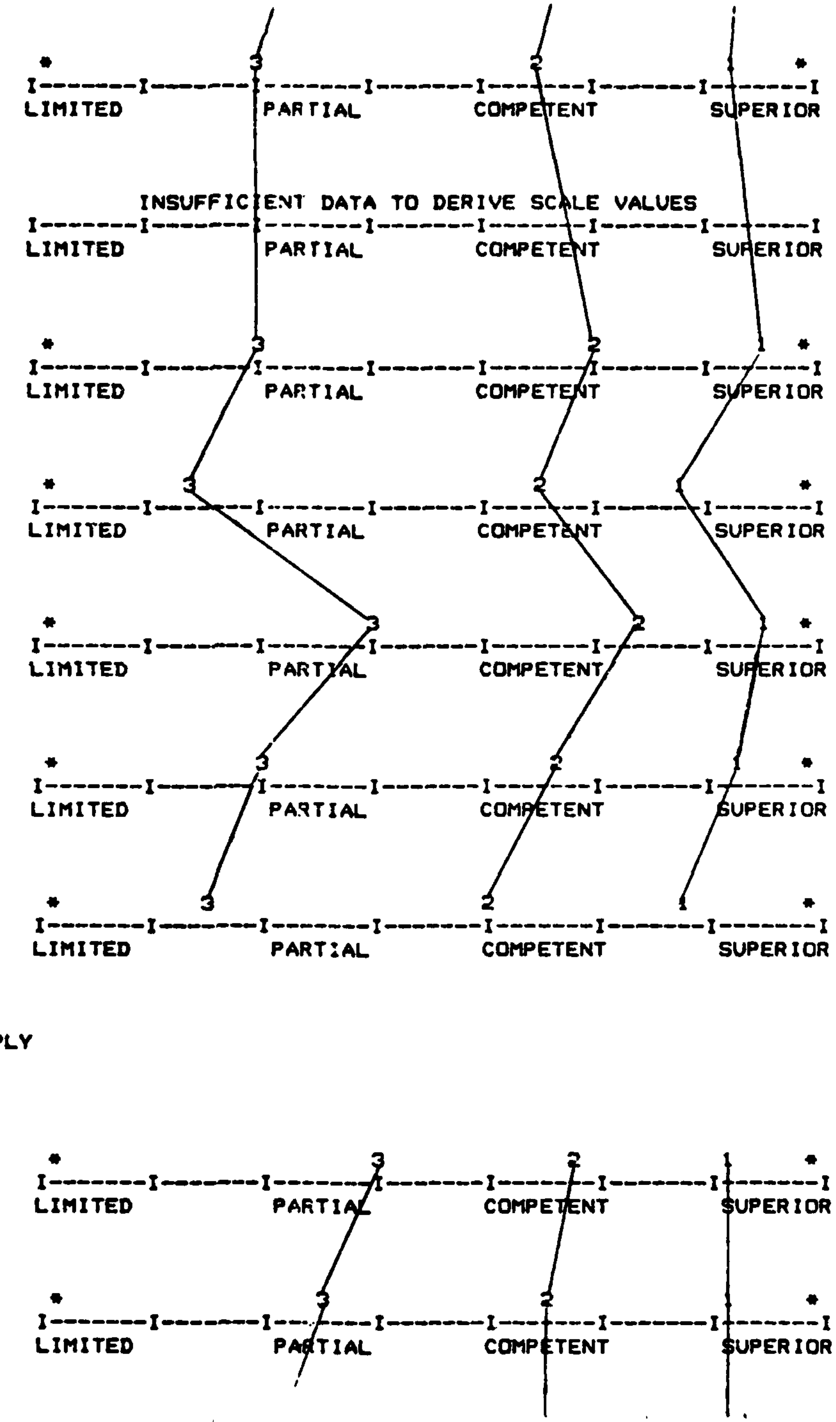
ET(R): RADAR ANTENNA/DRIVE SYSTEMS



```
CLEAN/LUBRICATE RADAR ANTENNA/         *               3          2            1    *  TIME CONSUMING: 50%
DRIVE SYSTEM                           I-------I-------I-------I-------I-------I-------I-------I
                                       LIMITED         PARTIAL         COMPETENT       SUPERIOR

TEST/INSPECT RADAR ANTENNA/DRIVE       *              3           2            1    *  TIME CONSUMING   0%
SYSTEM                                 I-------I-------I-------I-------I-------I-------I-------I
                                       LIMITED         PARTIAL         COMPETENT       SUPERIOR

LOCALIZE/ISOLATE RADAR ANTENNA/        *               3         2             1    *  TIME CONSUMING: 16%
DRIVE SYSTEM MALFUNCTION TO A          I-------I-------I-------I-------I-------I-------I-------I
UNIT                                   LIMITED         PARTIAL         COMPETENT       SUPERIOR

LOCALIZE/ISOLATE RADAR ANTENNA/        *          3             2          1        *  TIME CONSUMING: 16%
DRIVE SYSTEM MALFUNCTION TO THE        I-------I-------I-------I-------I-------I-------I-------I
COMPONENT LEVEL                        LIMITED         PARTIAL         COMPETENT       SUPERIOR

REMOVE/REPLACE RADAR ANTENNA/          *          3              2         1        *  TIME CONSUMING: 66%
DRIVE SYSTEM COMPONENTS                I-------I-------I-------I-------I-------I-------I-------I
                                       LIMITED         PARTIAL         COMPETENT       SUPERIOR

CALIBRATE/ALIGN/ADJUST RADAR           *          3          2            1         *  TIME CONSUMING: 16%
ANTENNA/DRIVE SYSTEM                   I-------I-------I-------I-------I-------I-------I-------I
                                       LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

ET(R): RADAR INDICATOR/CONSOLE

```
CLEAN RADAR INDICATOR/CONSOLE          *                3             2        1    *  TIME CONSUMING: 50%
                                       I-------I-------I-------I-------I-------I-------I-------I
                                       LIMITED         PARTIAL         COMPETENT       SUPERIOR
```



TEST/INSPECT RADAR INDICATOR/ CONSOLE	TIME CONSUMING: 0%
LOCALIZE/ISOLATE RADAR INDICATOR/ CONSOLE MALFUNCTION TO A UNIT	INSUFFICIENT DATA TO DERIVE SCALE VALUES
LOCALIZE-ISOLATE RADAR INDICATOR/ CONSOLE MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 25%
LOCALIZE/ISOLATE RADAR INDICATOR/ CONSOLE MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 50%
REMOVE/REPLACE RADAR INDICATOR/ CONSOLE MODULES/CARDS	TIME CONSUMING: 0%
REMOVE/REPLACE RADAR INDICATOR/ CONSOLE COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 25%
CALIBRATE/ALIGN/ADJUST RADAR INDICATOR/CONSOLE	TIME CONSUMING: 50%

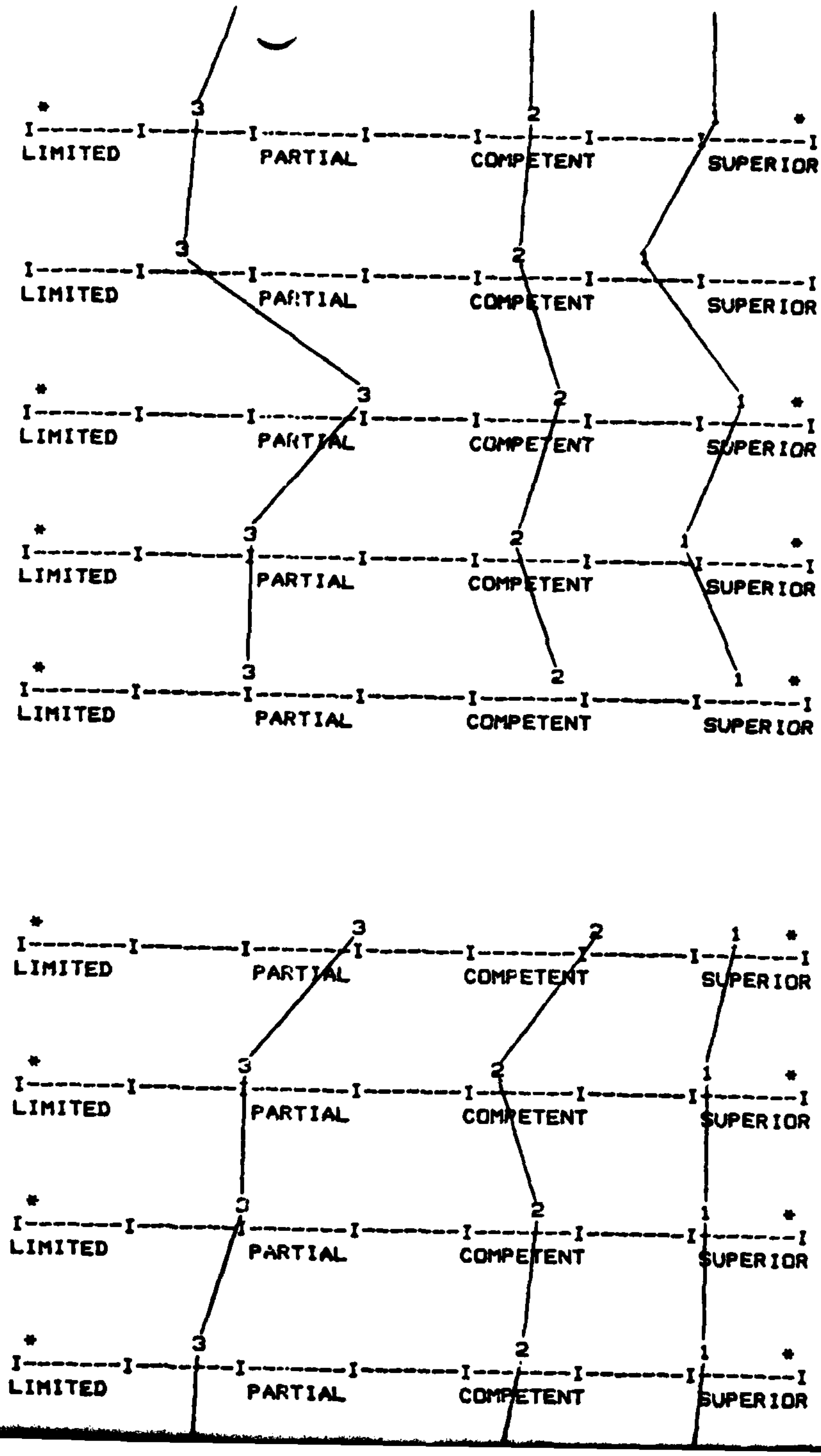
ET(R): RADAR POWER SUPPLY

CLEAN RADAR POWER SUPPLY	TIME CONSUMING: 0%
TEST/INSPECT RADAR POWER SUPPLY	TIME CONSUMING: 0%

LOCALIZE/ISOLATE RADAR POWER SUPPLY MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 16%
LOCALIZE/ISOLATE RADAR POWER SUPPLY MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 16%
REMOVE/REPLACE RADAR POWER SUPPLY MODULES/CARDS	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 0%
REMOVE/REPLACE RADAR POWER SUPPLY COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 16%
CALIBRATE/ALIGN/ADJUST RADAR POWER SUPPLY	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 0%

ET(R): RADAR RECEIVERS

CLEAN RADAR RECEIVERS	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 16%
TEST/INSPECT RADAR RECEIVERS	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 16%
LOCALIZE/ISOLATE RADAR RECEIVERS MALFUNCTION TO A UNIT	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 16%
LOCALIZE/ISOLATE RADAR RECEIVERS MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 33%



```
LOCALIZE/ISOLATE RADAR RECEIVERS          *      3           2       1   *  TIME CONSUMING: 16%
MALFUNCTION TO THE COMPONENT             I-------I-------I-------I-------I-------I-------I-------I
LEVEL, SUCH AS SWITCHES, RESISTORS,      LIMITED        PARTIAL         COMPETENT       SUPERIOR
CAPACITORS, TRANSISTORS, ICS, ETC.

REMOVE/REPLACE RADAR RECEIVERS            *             3         2      1   *  TIME CONSUMING:  0%
MODULES/CARDS                            I-------I-------I-------I-------I-------I-------I-------I
                                         LIMITED        PARTIAL         COMPETENT       SUPERIOR

REMOVE/REPLACE RADAR RECEIVERS            *          3          2         1  *  TIME CONSUMING: 33%
COMPONENTS, SUCH AS SWITCHES,            I-------I-------I-------I-------I-------I-------I-------I
RESISTORS, CAPACITORS, TRANSISTORS,      LIMITED        PARTIAL         COMPETENT       SUPERIOR
ICS, ETC.

CALIBRATE/ALIGN/ADJUST RADAR              *      3           2        1      *  TIME CONSUMING: 33%
RECEIVERS                                I-------I-------I-------I-------I-------I-------I-------I
                                         LIMITED        PARTIAL         COMPETENT       SUPERIOR
```

ET(R): RADAR REMOTE REPEATERS

```
CLEAN RADAR REMOTE REPEATERS                   INSUFFICIENT DATA TO DERIVE SCALE VALUES
                                         I-------I-------I-------I-------I-------I-------I-------I
                                         LIMITED        PARTIAL         COMPETENT       SUPERIOR

TEST/INSPECT RADAR REMOTE                      INSUFFICIENT DATA TO DERIVE SCALE VALUES
REPEATERS                                I-------I-------I-------I-------I-------I-------I-------I
                                         LIMITED        PARTIAL         COMPETENT       SUPERIOR

LOCALIZE/ISOLATE RADAR REMOTE                  INSUFFICIENT DATA TO DERIVE SCALE VALUES
REPEATERS                                I-------I-------I-------I-------I-------I-------I-------I
                                         LIMITED        PARTIAL         COMPETENT       SUPERIOR

LOCALIZE/ISOLATE RADAR REMOTE                  INSUFFICIENT DATA TO DERIVE SCALE VALUES
REPEATERS MALFUNCTION TO THE             I-------I-------I-------I-------I-------I-------I-------I
MODULE/CARD LEVEL                        LIMITED        PARTIAL         COMPETENT       SUPERIOR

LOCALIZE/ISOLATE RADAR REMOTE                  INSUFFICIENT DATA TO DERIVE SCALE VALUES
REPEATERS MALFUNCTION TO THE COM-        I-------I-------I-------I-------I-------I-------I-------I
PONENT LEVEL, SUCH AS SWITCHES, RESISTORS, LIMITED      PARTIAL         COMPETENT       SUPERIOR
CAPACITORS, TRANSISTORS, ICS, ETC.
```

	LIMITED PARTIAL COMPETENT SUPERIOR	
REMOVE/REPLACE RADAR REMOTE REPEATERS MODULES/CARDS	INSUFFICIENT DATA TO DERIVE SCALE VALUES	
REMOVE/REPLACE RADAR REMOTE REPEATERS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	INSUFFICIENT DATA TO DERIVE SCALE VALUES	
CALIBRATE/ALIGN/ADJUST RADAR REMOTE REPEATERS	INSUFFICIENT DATA TO DERIVE SCALE VALUES	

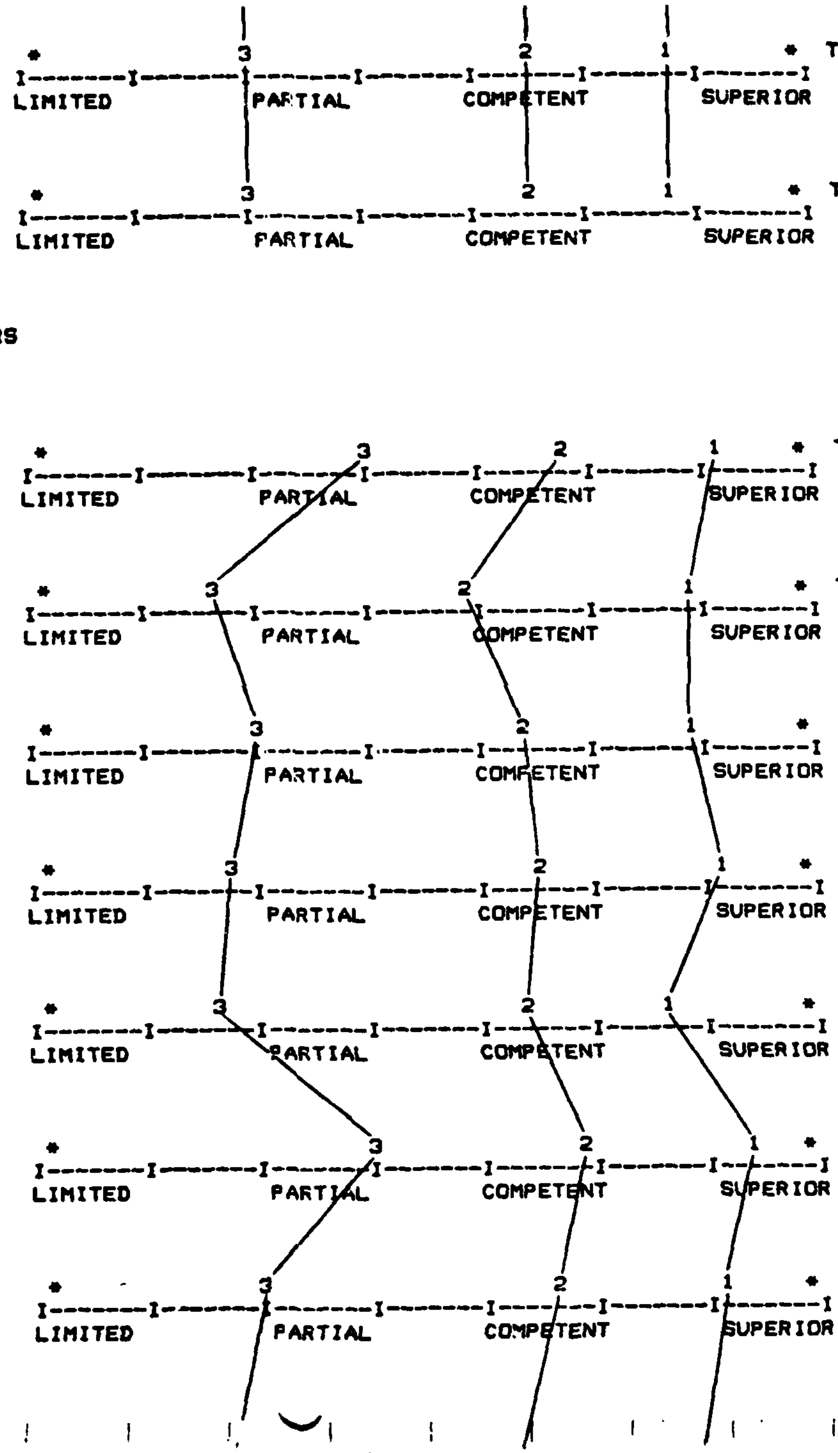
ET(R): RADAR SIGNAL DISTRIBUTION SYSTEM

Task	*	3	2	1	*	Time consuming
CLEAN RADAR SIGNAL DISTRIBUTION SYSTEM	LIMITED	PARTIAL	COMPETENT	SUPERIOR		TIME CONSUMING: 0%
TEST/INSPECT RADAR SIGNAL DISTRIBUTION SYSTEM	LIMITED	PARTIAL	COMPETENT	SUPERIOR		TIME CONSUMING: 0%
LOCALIZE/ISOLATE RADAR SIGNAL DISTRIBUTION SYSTEM MALFUNCTION TO A UNIT	LIMITED	PARTIAL	COMPETENT	SUPERIOR		TIME CONSUMING: 0%
LOCALIZE/ISOLATE RADAR SIGNAL DISTRIBUTION SYSTEM MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED	PARTIAL	COMPETENT	SUPERIOR		TIME CONSUMING: 0%
LOCALIZE/ISOLATE RADAR SIGNAL DISTRIBUTION SYSTEM MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED	PARTIAL	COMPETENT	SUPERIOR		TIME CONSUMING: 0%
REMOVE/REPLACE RADAR SIGNAL DISTRIBUTION SYSTEM MODULES/CARDS	LIMITED	PARTIAL	COMPETENT	SUPERIOR		TIME CONSUMING: 0%

REMOVE/REPLACE RADAR SIGNAL DISTRIBUTION SYSTEM COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.		TIME CONSUMING: 0%
CALIBRATE/ALIGN/ADJUST RADAR SIGNAL DISTRIBUTION SYSTEM		TIME CONSUMING: 0%

ET(R): RADAR TRANSMITTERS

CLEAN RADAR TRANSMITTERS		TIME CONSUMING: 0%
TEST/INSPECT RADAR TRANSMITTERS		TIME CONSUMING: 16%
LOCALIZE/ISOLATE RADAR TRANSMITTERS		TIME CONSUMING: 0%
LOCALIZE/ISOLATE RADAR TRANSMITTERS MALFUNCTION TO THE MODULE/CARD LEVEL		TIME CONSUMING: 0%
LOCALIZE/ISOLATE RADAR TRANSMITTERS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.		TIME CONSUMING: 16%
REMOVE/REPLACE RADAR TRANSMITTERS MODULES/CARDS		TIME CONSUMING: 16%
REMOVE/REPLACE RADAR TRANSMITTERS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.		TIME CONSUMING: 16%



* I-------I-------I-------I-------I-------I-------I-------I * TIME CONSUMING: 16%
LIMITED PARTIAL COMPETENT SUPERIOR

[illegible] VIDEO INDICATING DISPLAY

[illegible] RADAR VIDEO [illegible]

* I-------I-------I-------I-------I-------I-------I-------I * TIME CONSUMING: 0%
LIMITED PARTIAL COMPETENT SUPERIOR

[illegible] ISOLATE RADAR VIDEO
[illegible] DISPLAY MALFUNCTION
[illegible] MODULE/CARD LEVEL

* I-------I-------I-------I-------I-------I-------I-------I * TIME CONSUMING: 20%
LIMITED PARTIAL COMPETENT SUPERIOR

[illegible]/ISOLATE RADAR VIDEO
INDICATING DISPLAY MALFUNCTION
TO THE COMPONENT LEVEL, SUCH AS SWITCHES,
RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC

* I-------I-------I-------I-------I-------I-------I-------I * TIME CONSUMING: 20%
LIMITED PARTIAL COMPETENT SUPERIOR

REMOVE/REPLACE RADAR VIDEO
INDICATING DISPLAY MODULES/
CARDS

* I-------I-------I-------I-------I-------I-------I-------I * TIME CONSUMING: 0%
LIMITED PARTIAL COMPETENT SUPERIOR

REMOVE/REPLACE RADAR VIDEO
INDICATING DISPLAY COMPONENTS, SUCH
AS SWITCHES, RESISTORS, CAPACITORS,
TRANSISTORS, ICS, ETC.

* I-------I-------I-------I-------I-------I-------I-------I * TIME CONSUMING: 40%
LIMITED PARTIAL COMPETENT SUPERIOR

CALIBRATE/ALIGN/ADJUST RADAR
VIDEO INDICATING DISPLAY

* I-------I-------I-------I-------I-------I-------I-------I * TIME CONSUMING: 40%
LIMITED PARTIAL COMPETENT SUPERIOR

ET(R): RADAR VIDEO PROCESSING UNIT

TEST/INSPECT RADAR VIDEO PRO-
CESSING UNIT

* I-------I-------I-------I-------I-------I-------I-------I * TIME CONSUMING: 20%
LIMITED PARTIAL COMPETENT SUPERIOR

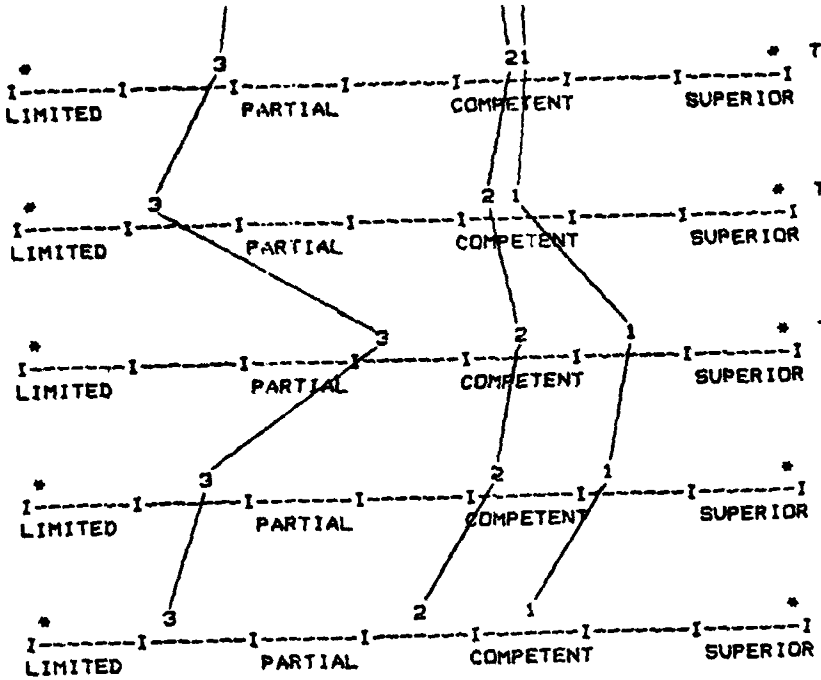
LOCALIZE/ISOLATE RADAR VIDEO PROCESSING UNIT MALFUNCTION TO THE MODULE/CARD LEVEL — * TIME CONSUMING: 33%

LOCALIZE/ISOLATE RADAR VIDEO PROCESSING UNIT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — * TIME CONSUMING: 50%

REMOVE/REPLACE RADAR VIDEO PROCESSING UNIT MODULES/CARDS — * TIME CONSUMING: 16%

REMOVE/REPLACE RADAR VIDEO PROCESSING UNIT COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — * TIME CONSUMING: 16%

CALIBRATE/ALIGN/ADJUST RADAR VIDEO PROCESSING UNIT — * TIME CONSUMING: 50%



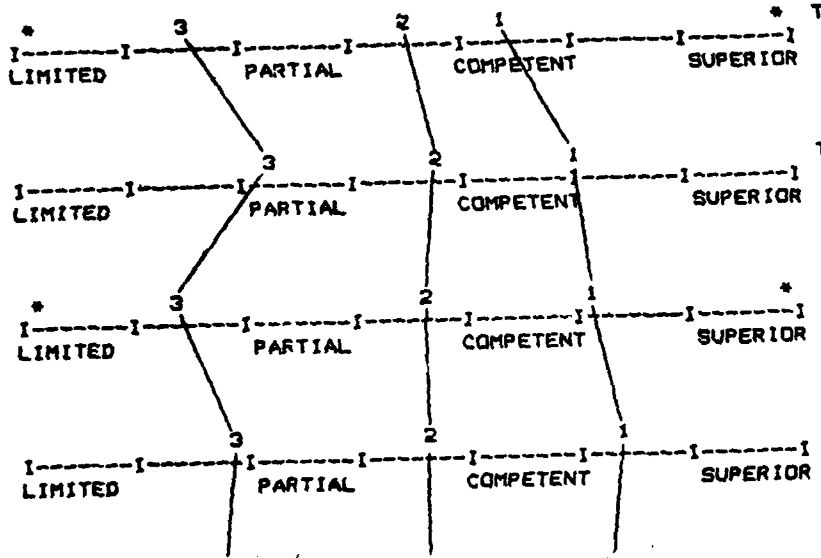
ET(R): SYNCHRO/SERVO AMPLIFIERS

TEST/INSPECT SYNCHRO/SERVO AMPLIFIERS — * TIME CONSUMING: 20%

LOCALIZE/ISOLATE SYNCHRO/SERVO AMPLIFIERS MALFUNCTION TO THE MODULE/CARD LEVEL — TIME CONSUMING: 14%

LOCALIZE/ISOLATE SYNCHRO/SERVO AMPLIFIERS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — * TIME CONSUMING: 16%

REMOVE/REPLACE SYNCHRO/SERVO AMPLIFIERS MODULES/CARDS — TIME CONSUMING: 14%



REMOVE/REPLACE SYNCHRO/SERVO AMPLIFIERS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — * 3 2 1 * LIMITED PARTIAL COMPETENT SUPERIOR — TIME CONSUMING: 16%

CALIBRATE/ALIGN/ADJUST SYNCHRO/SERVO AMPLIFIERS — 3 2 1 LIMITED PARTIAL COMPETENT SUPERIOR — TIME CONSUMING: 42%

ET(R): TEST EQUIPMENT

CLEAN/LUBRICATE TEST EQUIPMENT — 3 2 1 LIMITED PARTIAL COMPETENT SUPERIOR — TIME CONSUMING: 0%

TEST/INSPECT TEST EQUIPMENT — 3 2 1 LIMITED PARTIAL COMPETENT SUPERIOR — TIME CONSUMING: 10%

LOCALIZE/ISOLATE TEST EQUIPMENT MALFUNCTION TO THE MODULE/CARD LEVEL — 3 2 1 LIMITED PARTIAL COMPETENT SUPERIOR — TIME CONSUMING: 0%

LOCALIZE/ISOLATE TEST EQUIPMENT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — 3 2 1 LIMITED PARTIAL COMPETENT SUPERIOR — TIME CONSUMING: 0%

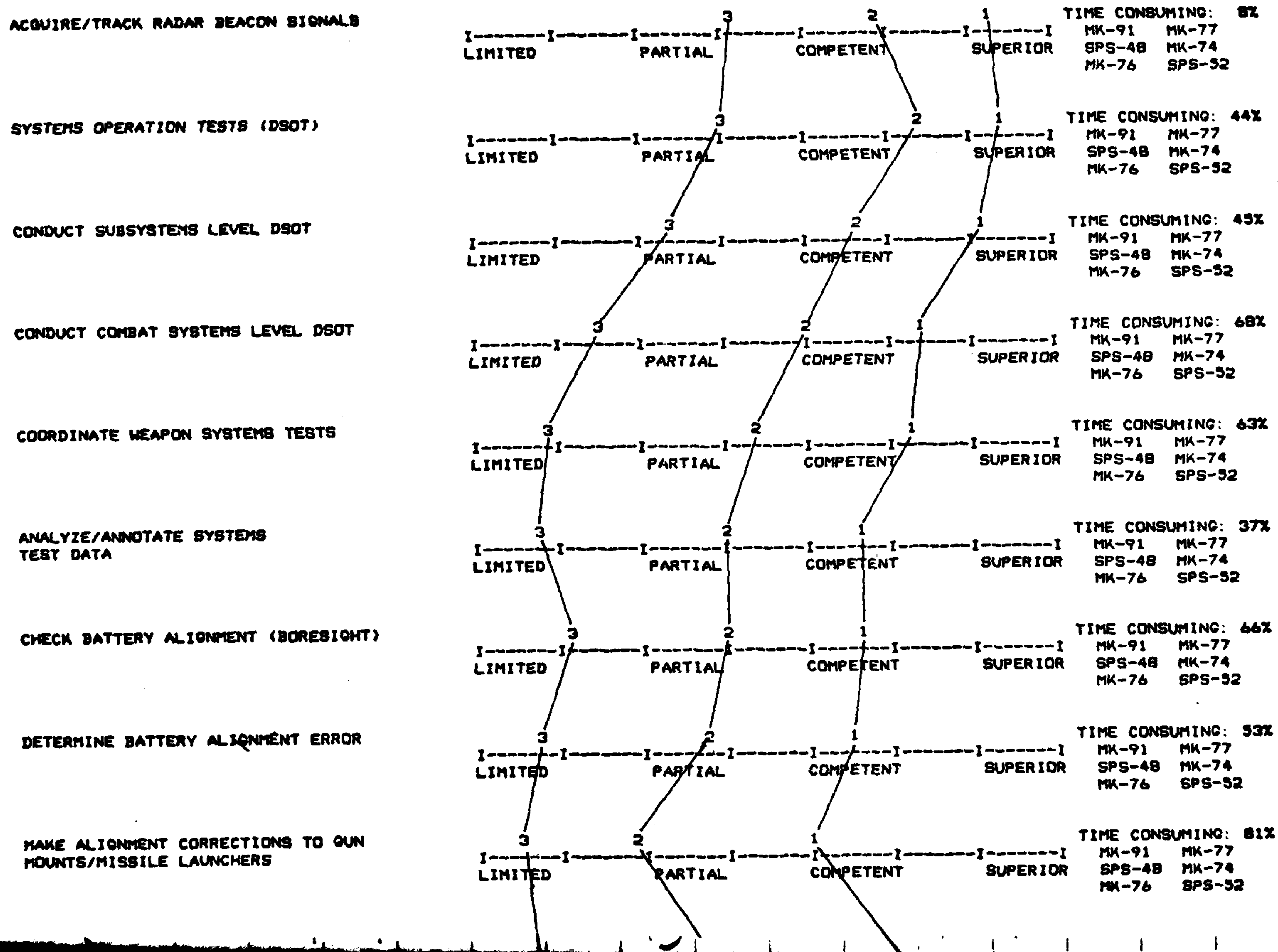
REMOVE/REPLACE TEST EQUIPMENT MODULES/CARDS — 3 2 1 LIMITED PARTIAL COMPETENT SUPERIOR — TIME CONSUMING: 0%

REMOVE/REPLACE TEST EQUIPMENT COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — 3 2 1 LIMITED PARTIAL COMPETENT SUPERIOR — TIME CONSUMING: 10%

CALIBRATE/ALIGN/ADJUST TEST EQUIPMENT — 3 2 1 LIMITED PARTIAL COMPETENT SUPERIOR — TIME CONSUMING: 50%

INDEX OF TASKS PERFORMED BY FT(M)s

FT(M): GENERAL OPERATION

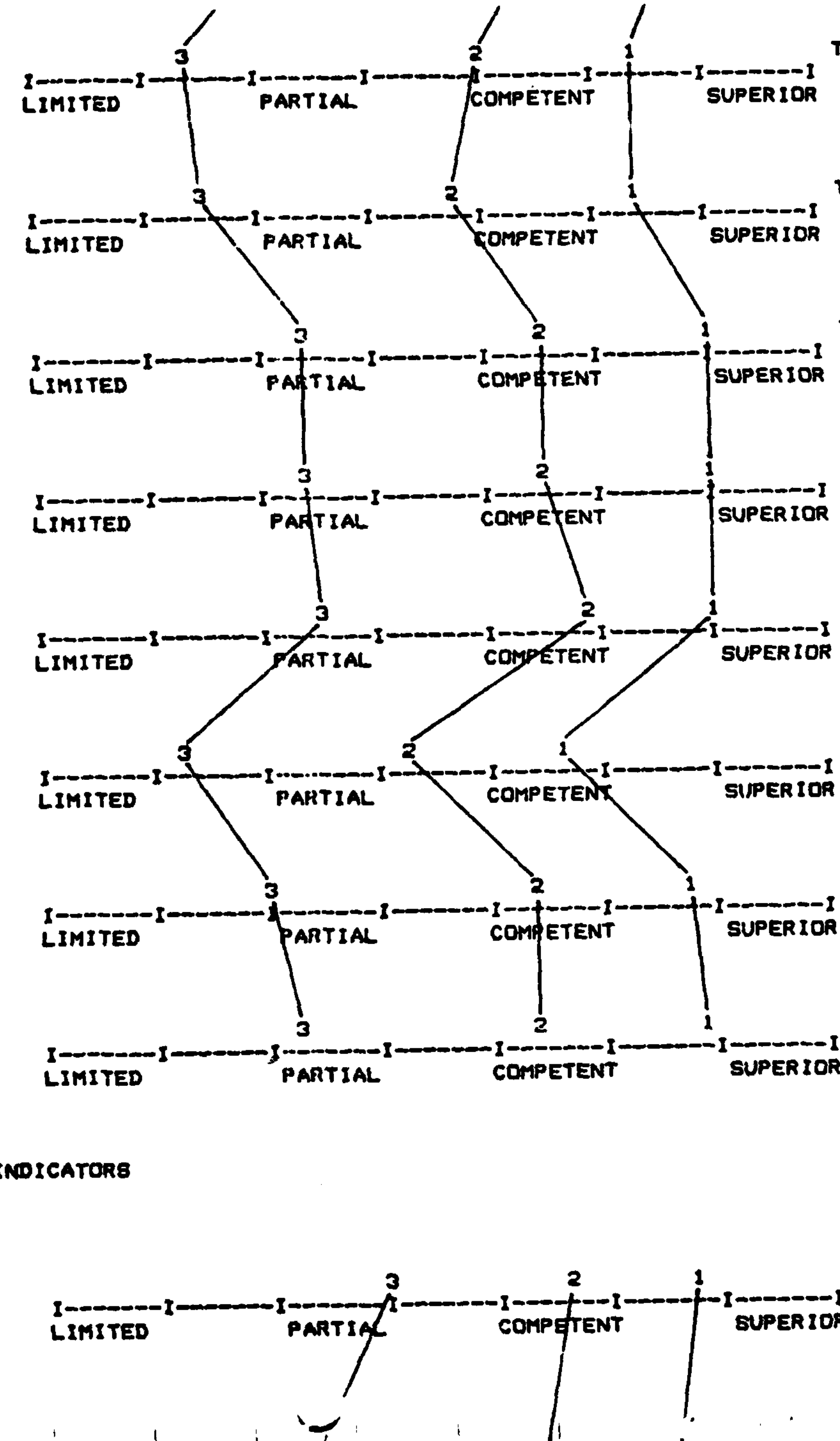


Task	3	2	1	LIMITED — PARTIAL — COMPETENT — SUPERIOR	Time Consuming
CONDUCT HORIZON CHECKS	LIMITED	PARTIAL	SUPERIOR	I-------I-------I-------I-------I-------I-------I-------I	TIME CONSUMING: 44% MK-74 MK-76 SPS-52
TRACK TARGETS BY AURAL MEANS	* LIMITED	LIMITED	LIMITED	I-------I-------I-------I-------I-------I-------I-------I *	TIME CONSUMING: 0% MK-91
TRACK TARGETS BY AURAL MEANS	INSUFFICIENT DATA TO DERIVE SCALE VALUES			I-------I-------I-------I-------I-------I-------I-------I	
TRACK TARGETS BY AURAL MEANS	PARTIAL	COMPETENT	SUPERIOR	I-------I-------I-------I-------I-------I-------I-------I	TIME CONSUMING: 0% MK-74
ANALYZE TARGETS BY AURAL MEANS	LIMITED	COMPETENT	SUPERIOR	I-------I-------I-------I-------I-------I-------I-------I	TIME CONSUMING: 6% MK-91 SPS-48 MK-74 SPS-52
INITIATE ELECTRONIC COUNTER COUNTERMEASURES (ECCM) ACTION FROM AURAL ANALYSIS	LIMITED	PARTIAL	COMPETENT	I-------I-------I-------I-------I-------I-------I-------I	TIME CONSUMING: 13% MK-91 SPS-48 MK-74 SPS-52
INSERT DATA INTO COMPUTERS MANUALLY	PARTIAL	COMPETENT	SUPERIOR	I-------I-------I-------I-------I-------I-------I-------I	TIME CONSUMING: 31% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52

FT(M): GENERAL MAINTENANCE

Task	3	2	1	LIMITED — PARTIAL — COMPETENT — SUPERIOR	Time Consuming
RESEARCH TECHNICAL PUBLICATIONS TO FIND APPROPRIATE SCHEMATICS/LOGIC DIAGRAMS/TABLES/TROUBLESHOOTING CHARTS MAINTENANCE INFORMATION/PART NUMBERS FOR SPECIFIC PIECES OF EQUIPMENT	PARTIAL	COMPETENT	SUPERIOR	I-------I-------I-------I-------I-------I-------I-------I	TIME CONSUMING: 35% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
IDENTIFY STANDARD ELECTRONIC/MECHANICAL SYMBOLS AS USED ON SCHEMATICS, LOGIC DIAGRAMS, FLOW CHARTS, ETC.	COMPETENT	COMPETENT	SUPERIOR	I-------I-------I-------I-------I-------I-------I-------I	TIME CONSUMING: 8% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52

MODIFY EQUIPMENT IN ACCORDANCE WITH SHIPALTS, ORDALTS, FIELD CHANGE ORDERS AND ELECTRONIC INFORMATION BULLETINS (EIBS)	TIME CONSUMING: 48%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CHANGE SYSTEM CONFIGURATION BY PATCHING OR BY SWITCHBOARD CHANGES	TIME CONSUMING: 34%	MK-77 SPS-48 MK-74 MK-76 SPS-52
ANALYZE EQUIPMENT FRONT PANEL INDICATORS FOR FAULT DETECTION	TIME CONSUMING: 8%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
USE TEST EQUIPMENT TO INJECT SIGNALS AND/OR TAKE READINGS	TIME CONSUMING: 13%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
ASSEMBLE/REPAIR CABLES AND TEST LEADS, SUCH AS CONNECTORS, PROBES, ETC.	TIME CONSUMING: 51%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
ALIGN/ADJUST MECHANICAL LINKAGES AND GEAR TRAINS	TIME CONSUMING: 62%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A SUBSYSTEM	TIME CONSUMING: 25%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A UNIT	TIME CONSUMING: 31%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52



FT(M): BEARING-RANGE INDICATORS

TEST/INSPECT BEARING-RANGE INDICATORS	TIME CONSUMING: 6%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52

LOCALIZE/ISOLATE BEARING-RANGE INDICATORS MALFUNCTION TO THE COMPONENT LEVEL

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 33%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

CALIBRATE/ALIGN/ADJUST BEARING-RANGE INDICATORS

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 42%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

FT(M): CONTINUOUS WAVE ILLUMINATION

CLEAN/LUBRICATE CONTINUOUS WAVE ILLUMINATION

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 18%
MK-77 MK-74
MK-76 SPS-52

TEST/INSPECT CONTINUOUS WAVE ILLUMINATION (CWI)

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 24%
MK-77 MK-74
MK-76 SPS-52

LOCALIZE/ISOLATE CONTINUOUS WAVE ILLUMINATION (CWI) MALFUNCTION TO THE COMPONENT LEVEL

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 25%
MK-77 MK-74
MK-76 SPS-52

REMOVE/REPLACE CONTINUOUS WAVE ILLUMINATION (CWI) COMPONENTS

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 54%
MK-77 MK-74
MK-76 SPS-52

FT(M): DESSICATED AIR/COOLANT SYSTEMS

CLEAN DESSICATED AIR/COOLANT SYSTEMS

* 3 2 1 *
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 100%
MK-91

CLEAN DESSICATED AIR/COOLANT SYSTEMS

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 11%
MK-77

CLEAN DESSICATED AIR/COOLANT SYSTEMS

* 3 2 1 *
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 80%
SPS-48

CLEAN DESSICATED AIR/COOLANT SYSTEMS

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 0%
MK-74

CLEAN DESSICATED AIR/COOLANT SYSTEMS

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 57%
MK-76

CLEAN DESSICATED AIR/COOLANT SYSTEMS

INSUFFICIENT DATA TO DERIVE SCALE VALUES
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TEST/INSPECT DESSICATED AIR/COOLANT SYSTEMS

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 14%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

REMOVE/REPLACE DESSICATED AIR/COOLANT SYSTEMS COMPONENTS

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 57%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

CALIBRATE/ALIGN/ADJUST DESSICATED AIR COOLANT SYSTEMS

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 39%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

FT(M): FIRE CONTROL COMPUTERS

CLEAN/LUBRICATE FIRE CONTROL COMPUTERS

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 25%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

TEST/INSPECT FIRE CONTROL COMPUTERS

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 14%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

LOCALIZE/ISOLATE FIRE CONTROL COMPUTERS MALFUNCTION TO A UNIT

```
                 3                2          1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

TIME CONSUMING: 20%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

LOCALIZE/ISOLATE FIRE CONTROL COMPUTERS MALFUNCTION TO THE MODULE/CARD LEVEL

```
              3                  2           1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

TIME CONSUMING: 36%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

LOCALIZE/ISOLATE FIRE CONTROL COMPUTERS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

```
             3                    2          1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

TIME CONSUMING: 37%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

REMOVE/REPLACE FIRE CONTROL COMPUTERS MODULES/CARDS

```
                               3             2      1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

TIME CONSUMING: 3%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

REMOVE/REPLACE FIRE CONTROL COMPUTERS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

```
                          3              2        1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

TIME CONSUMING: 20%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

CALIBRATE/ALIGN/ADJUST FIRE CONTROL COMPUTERS

```
                      3             2        1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

TIME CONSUMING: 35%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

FT(M): FIRE CONTROL DIRECTORS

CLEAN/LUBRICATE FIRE CONTROL DIRECTORS

```
                            3             2       1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

TIME CONSUMING: 46%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

TEST/INSPECT FIRE CONTROL DIRECTORS

```
                         3             2        1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

TIME CONSUMING: 15%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

LOCALIZE/ISOLATE FIRE CONTROL DIRECTORS MALFUNCTION TO A UNIT

```
                    3               2         1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED          PARTIAL        COMPETENT        SUPERIOR
```

TIME CONSUMING: 30%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

LOCALIZE/ISOLATE FIRE CONTROL DIRECTORS MALFUNCTION TO THE COMPONENT LEVEL

TIME CONSUMING: 53%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

REMOVE/REPLACE FIRE CONTROL DIRECTORS COMPONENTS

TIME CONSUMING: 56%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

CALIBRATE/ALIGN/ADJUST FIRE CONTROL DIRECTORS

TIME CONSUMING: 45%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

FT(M): RADAR ANTENNAS/DRIVE SYSTEMS

CLEAN/LUBRICATE RADAR ANTENNAS/ DRIVE SYSTEMS

TIME CONSUMING: 40%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

TEST/INSPECT RADAR ANTENNAS/ DRIVE SYSTEMS

TIME CONSUMING: 26%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

LOCALIZE/ISOLATE RADAR ANTENNAS/ DRIVE SYSTEMS MALFUNCTION TO THE COMPONENT LEVEL

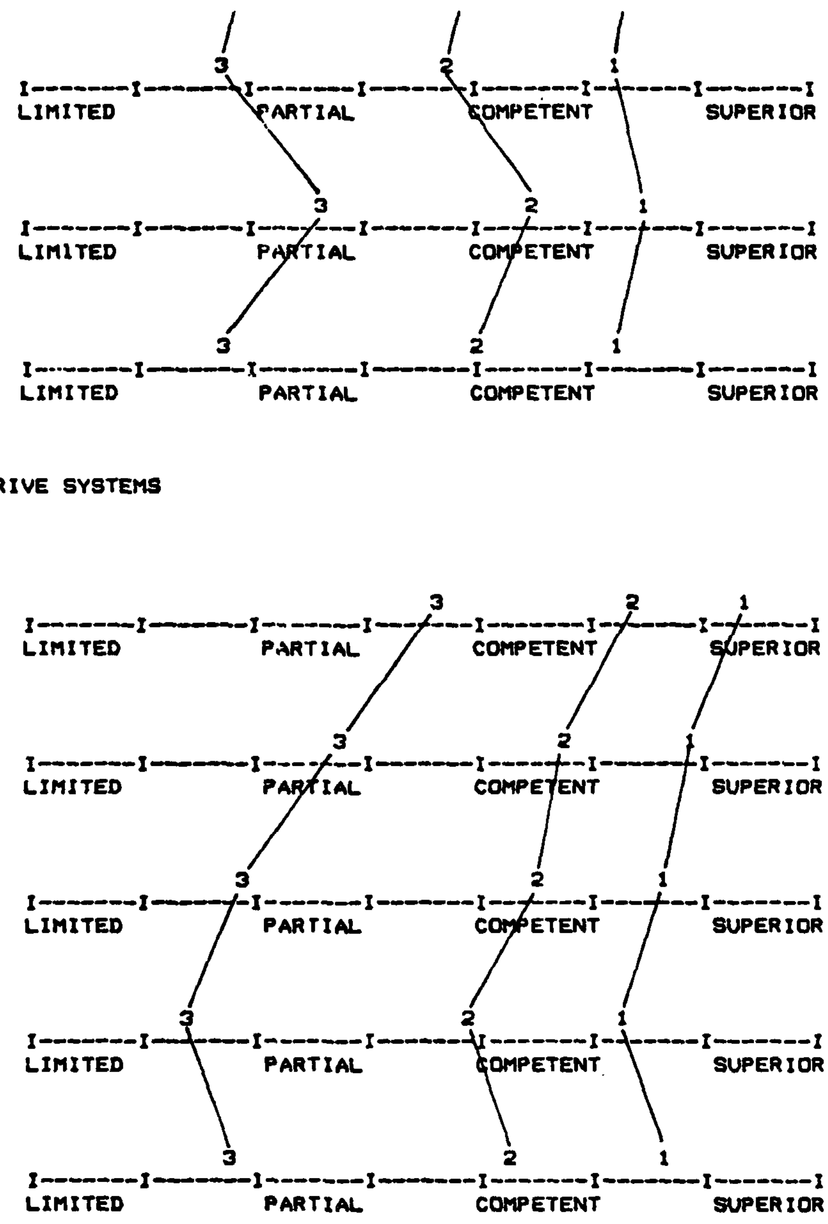
TIME CONSUMING: 42%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

REMOVE/REPLACE RADAR ANTENNAS/ DRIVE SYSTEMS COMPONENTS

TIME CONSUMING: 56%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

CALIBRATE/ALIGN/ADJUST RADAR ANTENNAS/DRIVE SYSTEMS

TIME CONSUMING: 61%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52



FT(M): RADAR CONSOLES

CLEAN/LUBRICATE RADAR CONSOLES

```
                                  3                    2       1
I-------I-------I-------I-------I-------I-------I-------I    TIME CONSUMING: 30%
LIMITED         PARTIAL         COMPETENT       SUPERIOR       MK-91    MK-77
                                                               SPS-48   MK-74
                                                               MK-76    SPS-52
```

TEST/INSPECT RADAR CONSOLES

```
                               3                 2       1
I-------I-------I-------I-------I-------I-------I-------I    TIME CONSUMING: 23%
LIMITED         PARTIAL         COMPETENT       SUPERIOR       MK-91    MK-77
                                                               SPS-48   MK-74
                                                               MK-76    SPS-52
```

LOCALIZE/ISOLATE RADAR CONSOLES MALFUNCTION TO THE MODULE/CARD LEVEL

```
                           3                    2        1
I-------I-------I-------I-------I-------I-------I-------I    TIME CONSUMING: 44%
LIMITED         PARTIAL         COMPETENT       SUPERIOR       MK-91    MK-77
                                                               SPS-48   MK-74
                                                               MK-76    SPS-52
```

LOCALIZE/ISOLATE RADAR CONSOLES MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

```
                         3                      2        1
I-------I-------I-------I-------I-------I-------I-------I    TIME CONSUMING: 47%
LIMITED         PARTIAL         COMPETENT       SUPERIOR       MK-91    MK-77
                                                               SPS-48   MK-74
                                                               MK-76    SPS-52
```

REMOVE/REPLACE CONSOLES MODULES/CARDS

```
                                  3                     2      1
I-------I-------I-------I-------I-------I-------I-------I    TIME CONSUMING:  5%
LIMITED         PARTIAL         COMPETENT       SUPERIOR       MK-91    MK-77
                                                               SPS-48   MK-74
                                                               MK-76    SPS-52
```

REMOVE/REPLACE RADAR CONSOLES COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

```
                               3                  2        1
I-------I-------I-------I-------I-------I-------I-------I    TIME CONSUMING: 38%
LIMITED         PARTIAL         COMPETENT       SUPERIOR       MK-91    MK-77
                                                               SPS-48   MK-74
                                                               MK-76    SPS-52
```

CALIBRATE/ALIGN/ADJUST RADAR CONSOLES

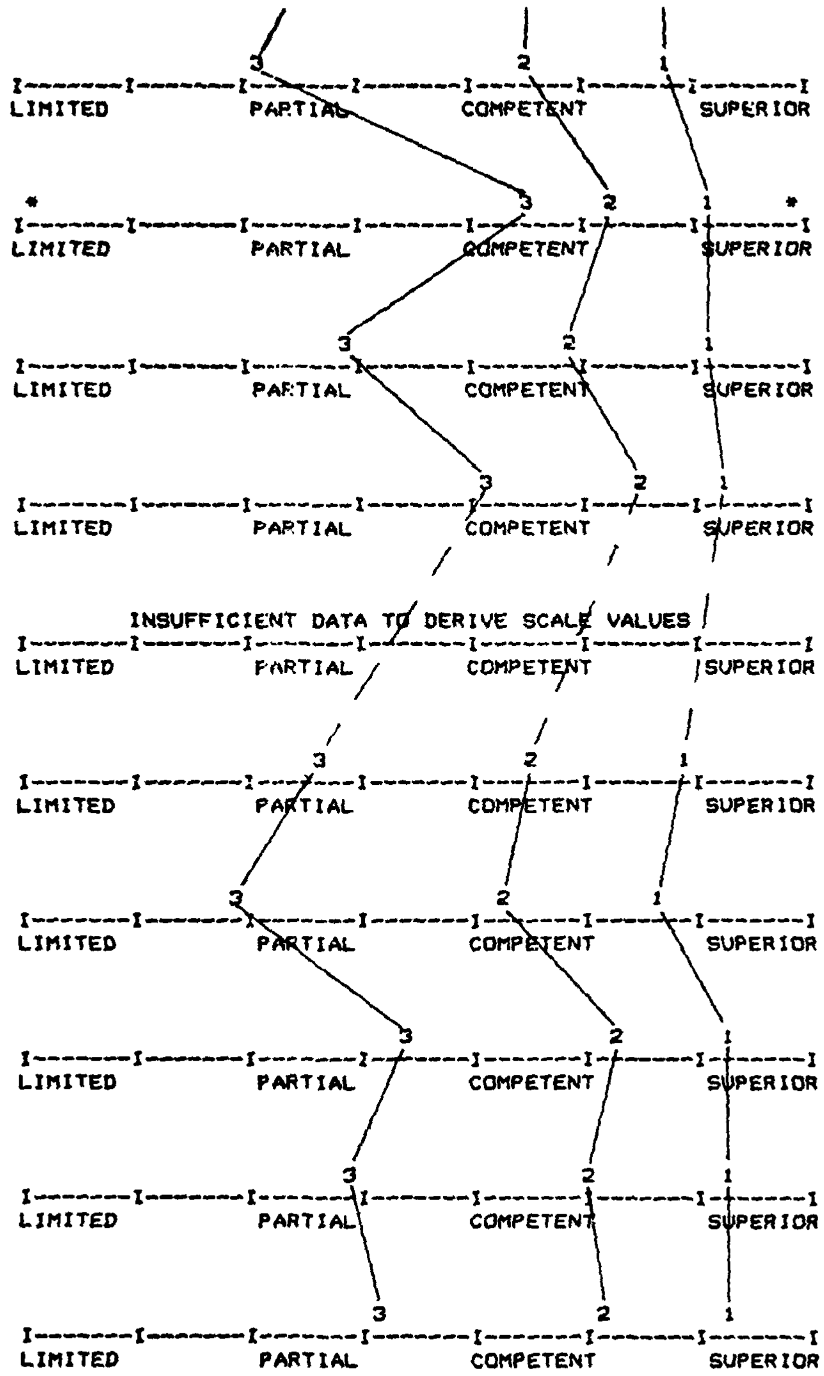
```
                          3                   2        1
I-------I-------I-------I-------I-------I-------I-------I    TIME CONSUMING: 45%
LIMITED         PARTIAL         COMPETENT       SUPERIOR       MK-91    MK-77
                                                               SPS-48   MK-74
                                                               MK-76    SPS-52
```

FT(M): RADAR POWER SUPPLY

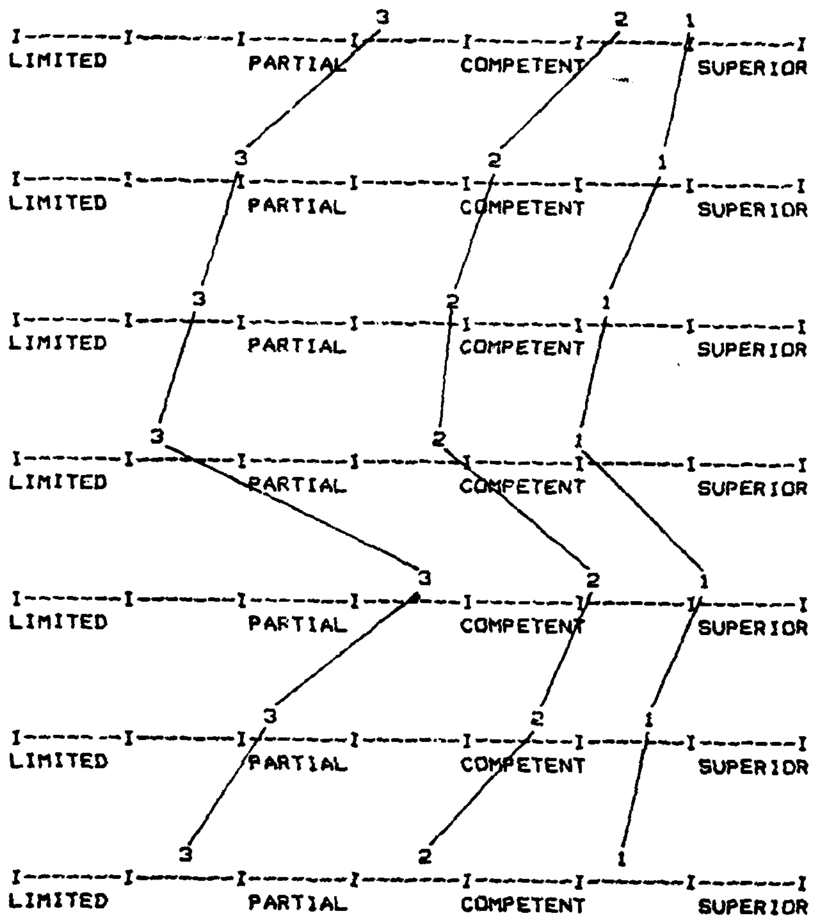
TEST/INSPECT RADAR POWER SUPPLY

```
 *                                   3       2       1       *
I-------I-------I-------I-------I-------I-------I-------I    TIME CONSUMING:  0%
LIMITED         PARTIAL         COMPETENT       SUPERIOR       MK-91
```

Task	Time consuming	Systems
TEST/INSPECT RADAR POWER SUPPLY	0%	MK-77
TEST/INSPECT RADAR POWER SUPPLY	20%	SPS-48
TEST/INSPECT RADAR POWER SUPPLY	11%	MK-74
TEST/INSPECT RADAR POWER SUPPLY	0%	MK-76
TEST/INSPECT RADAR POWER SUPPLY		
LOCALIZE/ISOLATE RADAR POWER SUPPLY MALFUNCTION TO THE MODULE/ CARD LEVEL	15%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR POWER SUPPLY MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	27%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/ REPLACE RADAR POWER SUPPLY MODULES/CARDS	2%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE RADAR POWER SUPPLY COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	28%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST RADAR POWER SUPPLY	11%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52



FT(M): RADAR RANGING UNITS



CLEAN/LUBRICATE RADAR RANGING UNITS
TIME CONSUMING 10%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

TEST/INSPECT RADAR RANGING UNITS
TIME CONSUMING 32%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

LOCALIZE/ISOLATE RADAR RANGING UNITS MALFUNCTION TO THE MODULE/CARD LEVEL
TIME CONSUMING 44%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

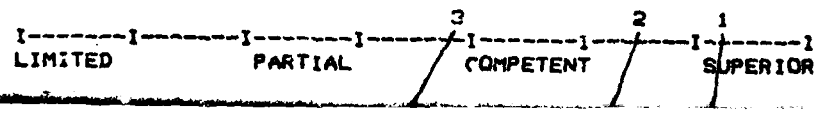
LOCALIZE/ISOLATE RADAR RANGING UNITS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.
TIME CONSUMING: 48%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

REMOVE/REPLACE RADAR RANGING UNITS MODULES/CARDS
TIME CONSUMING 14%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

REMOVE/REPLACE RADAR RANGING UNITS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.
TIME CONSUMING: 34%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

CALIBRATE/ALIGN/ADJUST RADAR RANGING UNITS
TIME CONSUMING: 46%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

FT(M): RADAR RECEIVERS



CLEAN RADAR RECEIVERS
TIME CONSUMING: 14%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

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AN ENGINEER'S GUIDE TO THE USE OF HUMAN RESOURCES IN ELECTRONIC--ETC(U)
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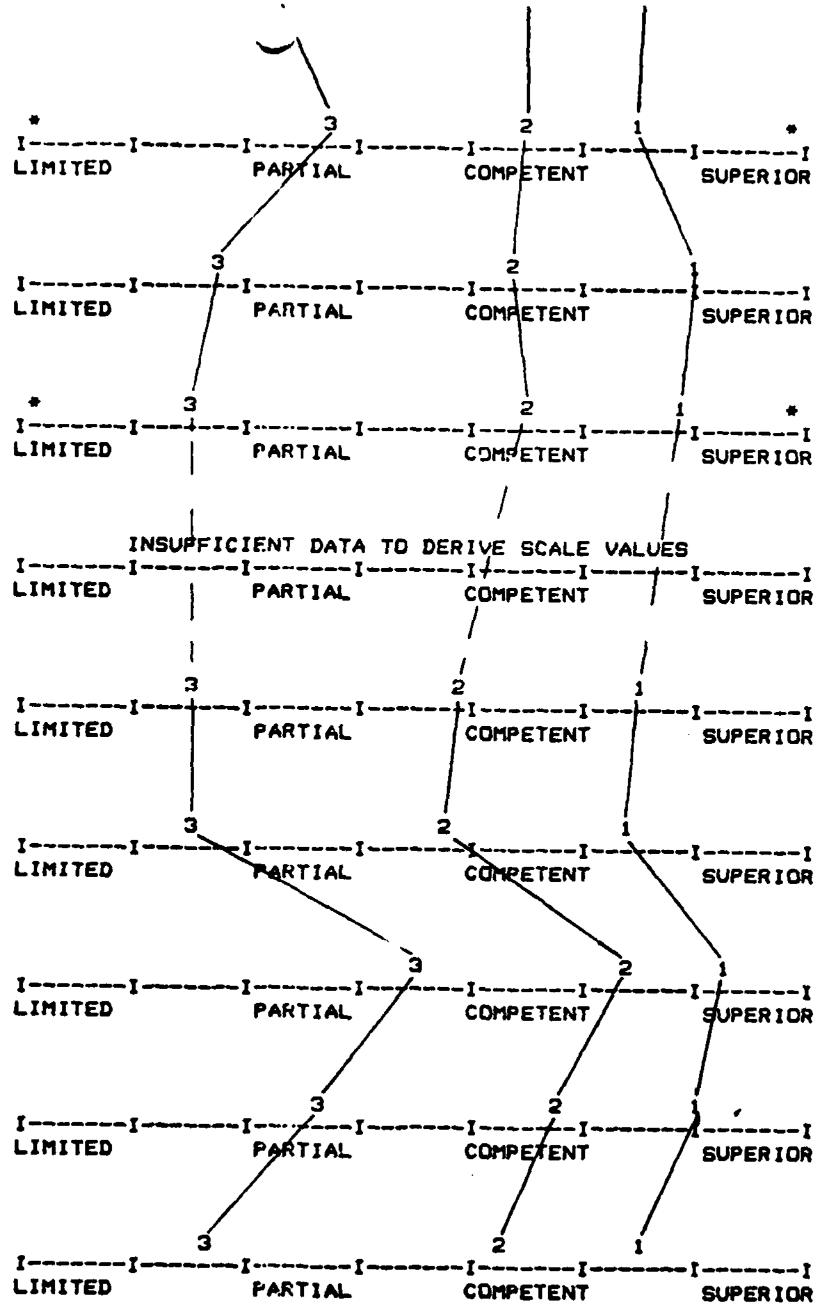
Task	Rating scale	Time consuming
TEST/INSPECT RADAR RECEIVERS	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 37% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR RECEIVERS MALFUNCTION TO A UNIT	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 28% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR RECEIVERS MALFUNCTION TO THE MODULE/CARD LEVEL	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 26% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR RECEIVERS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 37% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE RADAR RECEIVERS MODULES/CARDS	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 9% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE RADAR RECEIVERS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 35% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST RADAR RECEIVERS	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 64% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52

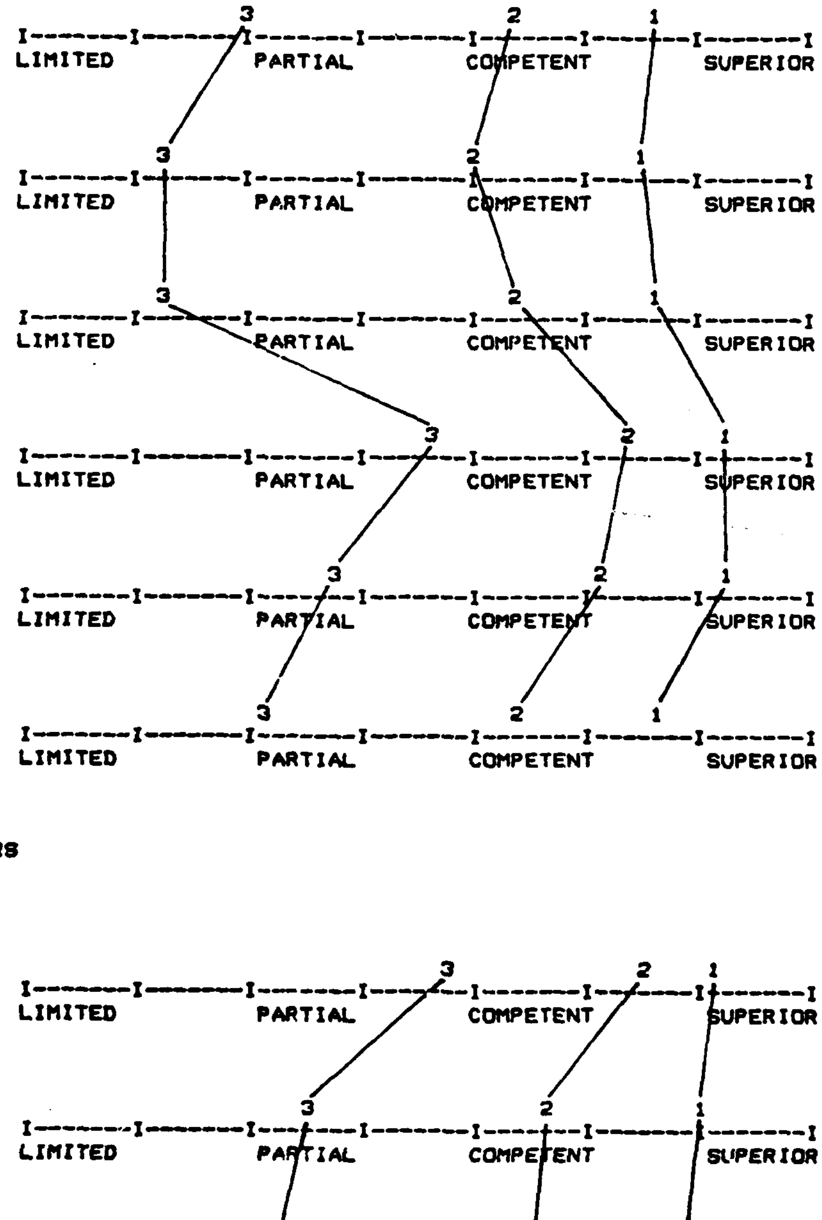
FT(M): RADAR SIGNAL PROCESSING EQUIPMENT

Task	Rating scale	Time consuming
TEST/INSPECT RADAR SIGNAL PROCESSING EQUIPMENT	* 3 2 1 * I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 0% MK-91
TEST/INSPECT RADAR SIGNAL PROCESSING EQUIPMENT	3 2 1 I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 16% MK-77

Task	Time Consuming
TEST/INSPECT RADAR SIGNAL PROCESSING EQUIPMENT	TIME CONSUMING: 100% SPS-48
TEST/INSPECT RADAR SIGNAL PROCESSING EQUIPMENT	TIME CONSUMING: 25% MK-74
TEST/INSPECT RADAR SIGNAL PROCESSING EQUIPMENT	TIME CONSUMING: 0% MK-76
TEST/INSPECT RADAR SIGNAL PROCESSING EQUIPMENT	
LOCALIZE/ISOLATE RADAR SIGNAL PROCESSING EQUIPMENT MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 38% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR SIGNAL PROCESSING EQUIPMENT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 40% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE RADAR SIGNAL PROCESSING EQUIPMENT MODULES/CARDS	TIME CONSUMING: 3% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE SIGNAL PROCESSING EQUIPMENT COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 40% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST RADAR SIGNAL PROCESSING EQUIPMENT	TIME CONSUMING: 38% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52



FT(M): RADAR TRACKING UNIT



TEST/INSPECT RADAR TRACKING UNIT — TIME CONSUMING: 12%
MK-91 MK-77
MK-74 MK-76
SPS-52

LOCALIZE/ISOLATE RADAR TRACKING UNIT MALFUNCTION TO THE MODULE/CARD LEVEL — TIME CONSUMING: 30%
MK-91 MK-77
MK-74 MK-76
SPS-52

LOCALIZE/ISOLATE RADAR TRACKING UNIT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — TIME CONSUMING: 36%
MK-91 MK-77
MK-74 MK-76
SPS-52

REMOVE/REPLACE RADAR TRACKING UNIT MODULES/CARDS — TIME CONSUMING: 0%
MK-91 MK-77
MK-74 MK-76
SPS-52

REMOVE/REPLACE RADAR TRACKING UNIT COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — TIME CONSUMING: 31%
MK-91 MK-77
MK-74 MK-76
SPS-52

CALIBRATE/ALIGN/ADJUST RADAR TRACKING UNIT — TIME CONSUMING: 45%
MK-91 MK-77
MK-74 MK-76
SPS-52

FT(M): RADAR TRANSMITTERS

CLEAN RADAR TRANSMITTERS — TIME CONSUMING: 38%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

TEST/INSPECT RADAR TRANSMITTERS — TIME CONSUMING: 37%
MK-91 MK-77
SPS-48 MK-74
MK-76 SPS-52

LOCALIZE/ISOLATE RADAR TRANSMITTERS MALFUNCTION TO A UNIT	LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 33%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR TRANSMITTERS MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 37%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR TRANSMITTERS MALFUNCTION TO THE COMPONENT LEVEL SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 57%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE RADAR TRANSMITTERS MODULES/CARDS	LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 14%	MK-91 MK-77 SPS-49 MK-74 MK-76 SPS-52
REMOVE/REPLACE RADAR TRANSMITTERS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 31%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST RADAR TRANSMITTERS	LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 50%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52

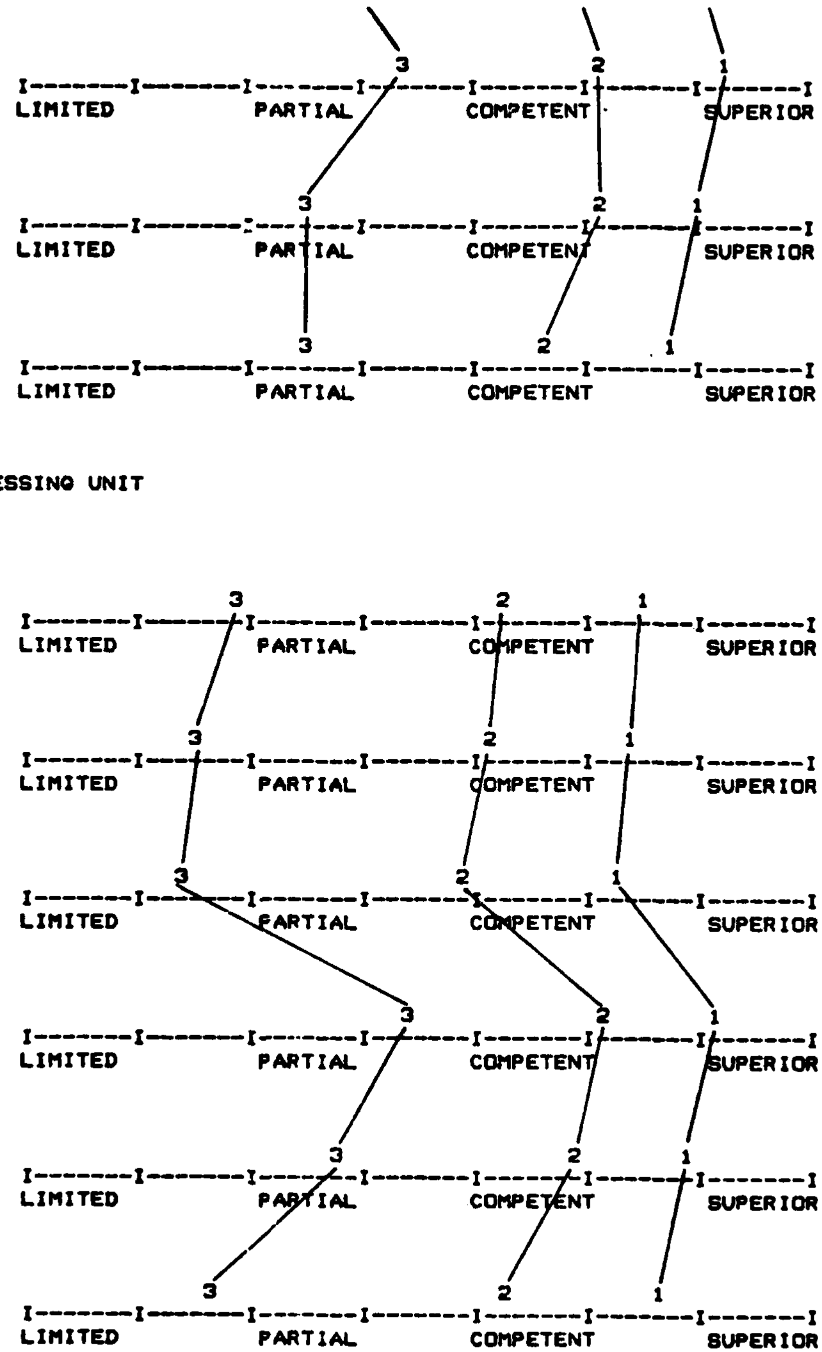
FT(M): RADAR VIDEO INDICATING DISPLAY

TEST/INSPECT RADAR VIDEO INDICATING DISPLAY	LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 26%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR VIDEO INDICATING DISPLAY MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 42%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR VIDEO INDICATING DISPLAY MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS,	LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 40%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52

Task	Time consuming	Systems
REMOVE/REPLACE RADAR VIDEO INDICATING DISPLAY MODULES/CARDS	TIME CONSUMING: 9%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE RADAR VIDEO INDICATING DISPLAY COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 31%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST RADAR VIDEO INDICATING DISPLAY	TIME CONSUMING: 38%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52

FT(M): RADAR VIDEO PROCESSING UNIT

Task	Time consuming	Systems
TEST/INSPECT RADAR VIDEO PROCESSING UNIT	TIME CONSUMING: 17%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR VIDEO PROCESSING UNIT MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 42%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR VIDEO PROCESSING UNIT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 42%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE RADAR VIDEO PROCESSING UNIT MODULES/CARDS	TIME CONSUMING: 7%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE RADAR VIDEO PROCESSING UNIT COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 35%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST RADAR VIDEO PROCESSING UNIT	TIME CONSUMING: 50%	MK-77 SPS-48 MK-74 MK-76 SPS-52



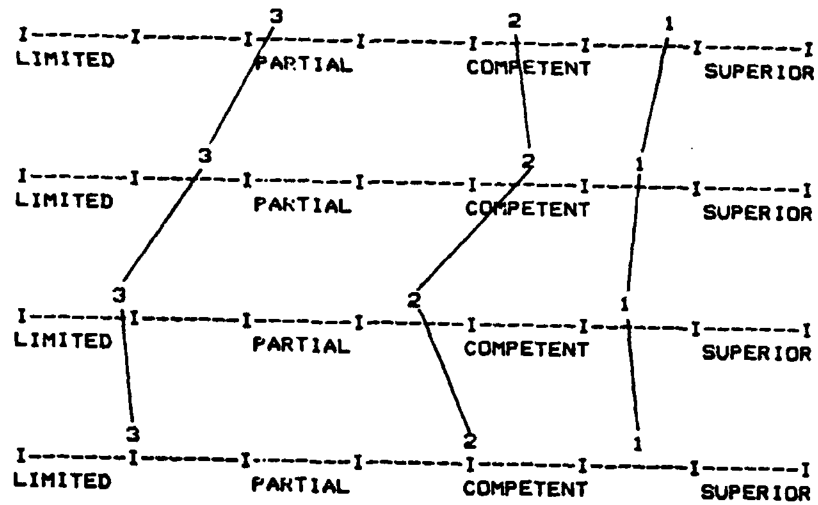
FT(M): STABLE ELEMENTS/STABLE VERTICALS

CLEAN/LUBRICATE STABLE ELEMENTS/ STABLE VERTICALS — TIME CONSUMING: 18% — MK-77, MK-74, SPS-52

TEST/INSPECT STABLE ELEMENTS/ STABLE VERTICALS — TIME CONSUMING: 18% — MK-77, MK-74, SPS-52

LOCALIZE/ISOLATE STABLE ELEMENTS/ STABLE VERTICALS MALFUNCTION TO THE COMPONENT LEVEL — TIME CONSUMING: 27% — MK-77, MK-74, SPS-52

REMOVE/REPLACE STABLE ELEMENTS/ STABLE VERTICAL COMPONENTS — TIME CONSUMING: 40% — MK-77, MK-74, SPS-52



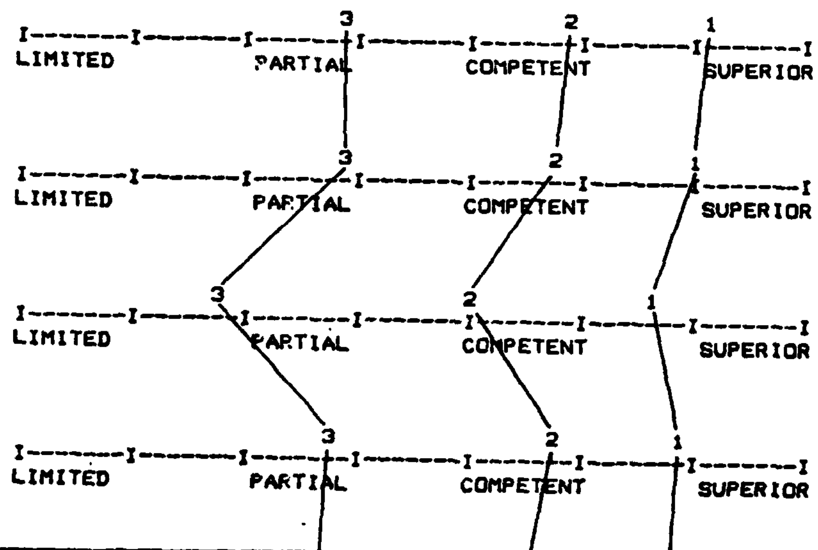
FT(M): SWITCHBOARDS

CLEAN/LUBRICATE SWITCHBOARDS — TIME CONSUMING: 58% — MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52

TEST/INSPECT SWITCHBOARDS — TIME CONSUMING: 27% — MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52

LOCALIZE/ISOLATE SWITCHBOARDS MALFUNCTION TO THE COMPONENT LEVEL — TIME CONSUMING: 50% — MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52

REMOVE/REPLACE SWITCHBOARDS COMPONENTS — TIME CONSUMING: 51% — MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52



Task	Scale	Time consuming
CALIBRATE/ALIGN/ADJUST SWITCHBOARDS	LIMITED — PARTIAL — COMPETENT — SUPERIOR (3 2 1)	TIME CONSUMING: 39% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52

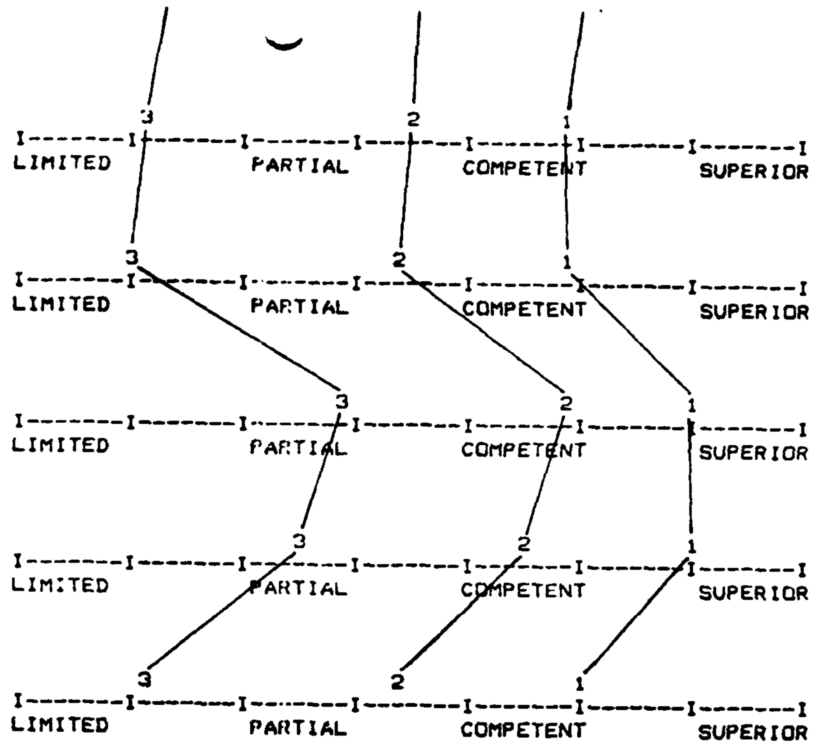
FT(M): SYNCHRO/SERVO SYSTEMS

Task	Scale	Time consuming
CLEAN/LUBRICATE SYNCHRO/SERVO SYSTEMS	LIMITED — PARTIAL — COMPETENT — SUPERIOR (3 2 1)	TIME CONSUMING: 32% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
TEST/INSPECT SYNCHRO/SERVO SYSTEMS	LIMITED — PARTIAL — COMPETENT — SUPERIOR (3 2 1)	TIME CONSUMING: 29% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE SYNCHRO-SERVO SYSTEMS MALFUNCTION TO THE COMPONENT LEVEL	LIMITED — PARTIAL — COMPETENT — SUPERIOR (3 2 1)	TIME CONSUMING: 35% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE SYNCHRO-SERVO SYSTEMS COMPONENTS	LIMITED — PARTIAL — COMPETENT — SUPERIOR (3 2 1)	TIME CONSUMING: 33% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST SYNCHRO-SERVO SYSTEMS	LIMITED — PARTIAL — COMPETENT — SUPERIOR (3 2 1)	TIME CONSUMING: 42% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52

FT(M): TARGET DESIGNATION EQUIPMENT

Task	Scale	Time consuming
TEST/INSPECT TARGET DESIGNATION EQUIPMENT	LIMITED — PARTIAL — COMPETENT — SUPERIOR (3 2 1)	TIME CONSUMING: 20% MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE TARGET DESIGNATION EQUIPMENT MALFUNCTION TO A UNIT	LIMITED — PARTIAL — COMPETENT — SUPERIOR (3 2 1)	TIME CONSUMING: 28% MK-77 SPS-48 MK-74 MK-76 SPS-52

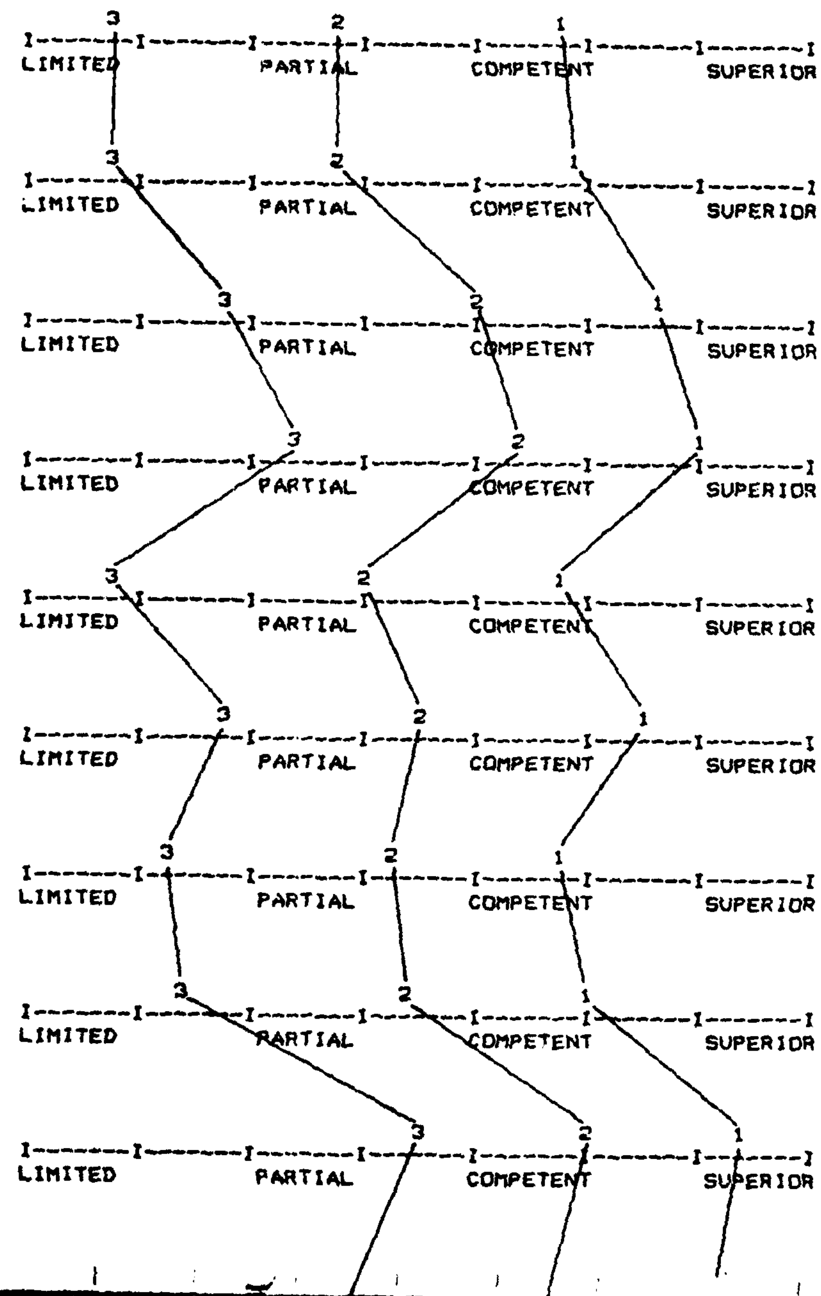
LOCALIZE/ISOLATE TARGET DESIGNATION EQUIPMENT MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 19%	MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE TARGET DESIGNATION EQUIPMENT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 28%	MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE TARGET DESIGNATION EQUIPMENT MODULES/CARDS	TIME CONSUMING: 9%	MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE TARGET DESIGNATION EQUIPMENT COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 19%	MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST TARGET DESIGNATION EQUIPMENT	TIME CONSUMING: 38%	MK-77 SPS-48 MK-74 MK-76 SPS-52



INDEX OF TASKS PERFORMED BY RMs

RM: GENERAL MAINTENANCE

RESEARCH TECHNICAL PUBLICATIONS TO FIND APPROPRIATE SCHEMATICS/LOGIC DIAGRAMS/ TABLES/TROUBLESHOOTING CHARTS/MAINTENANCE INFORMATION/PART NUMBERS FOR SPECIFIC PIECES OF EQUIPMENT	TIME CONSUMING: 57%
IDENTIFY STANDARD ELECTRONIC/MECHANICAL SYMBOLS AS USED ON SCHEMATICS, LOGIC DIAGRAMS, FLOW CHARTS, ETC.	TIME CONSUMING: 42%
CHANGE SYSTEM CONFIGURATION BY PATCHING OR BY SWITCHBOARD CHANGES	TIME CONSUMING: 25%
ANALYZE EQUIPMENT FRONT PANEL INDICATORS FOR FAULT DETECTION	TIME CONSUMING: 25%
USE TEST EQUIPMENT TO INJECT SIGNALS AND/OR TAKE READINGS	TIME CONSUMING: 12%
ASSEMBLE/REPAIR CABLES AND TEST LEADS, SUCH AS CONNECTORS, PROBES, ETC.	TIME CONSUMING: 42%
LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A SUBSYSTEM	TIME CONSUMING: 25%
LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A UNIT	TIME CONSUMING: 25%
CLEAN MISCELLANEOUS RADIO EQUIPMENT	TIME CONSUMING: 37%



TEST/INSPECT RADIO EQUIPMENT	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 50%
CLEAN/LUBRICATE ANTENNAS	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 87%
TEST/INSPECT ANTENNAS	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 62%
LOCALIZE/ISOLATE ANTENNAS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS INSULATORS, PEDESTALS, BASES, CONDUCTORS, ETC.	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 57%
REMOVE/REPLACE ANTENNA COMPONENTS, SUCH AS INSULATORS, PEDESTALS, BASES, CONDUCTORS, ETC.	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 100%

RM: ABNORMAL CONDITIONS

OVERHEATING (RECOGNIZE/UNDERSTAND EFFECTS OF)	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 0%
VARIATION IN PRIMARY POWER (RECOGNIZE/UNDERSTAND EFFECTS OF)	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 0%
UNAUTHORIZED PERSONNEL TAMPERING WITH SYSTEM (RECOGNIZE/UNDERSTAND EFFECTS OF)	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 12%
ADVERSE ATMOSPHERIC CONDITIONS (RECOGNIZE/UNDERSTAND EFFECTS OF)	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 0%

RM: EMERGENCIES AND/OR CASUALTIES

BLOWN FUSES
(RECOGNIZE/UNDERSTAND EFFECTS OF) — TIME CONSUMING: 0%

LOSS OF PRIMARY POWER
(RECOGNIZE/UNDERSTAND EFFECTS OF) — TIME CONSUMING: 12%

EQUIPMENT MALFUNCTION
(RECOGNIZE/UNDERSTAND EFFECTS OF) — TIME CONSUMING: 12%

PERSONNEL ERROR
(RECOGNIZE/UNDERSTAND EFFECTS OF) — TIME CONSUMING: 12%

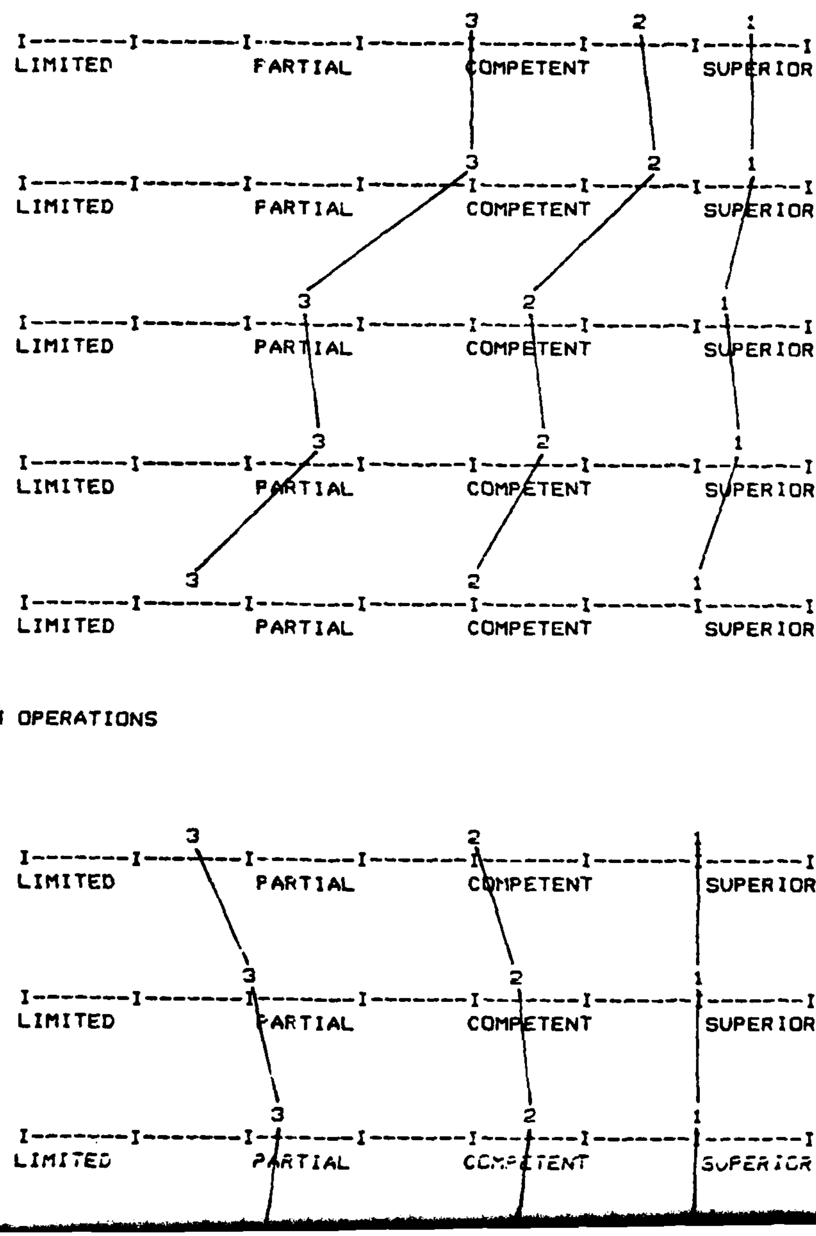
OPEN PATCH CORD
(RECOGNIZE/UNDERSTAND EFFECTS OF) — TIME CONSUMING: 25%

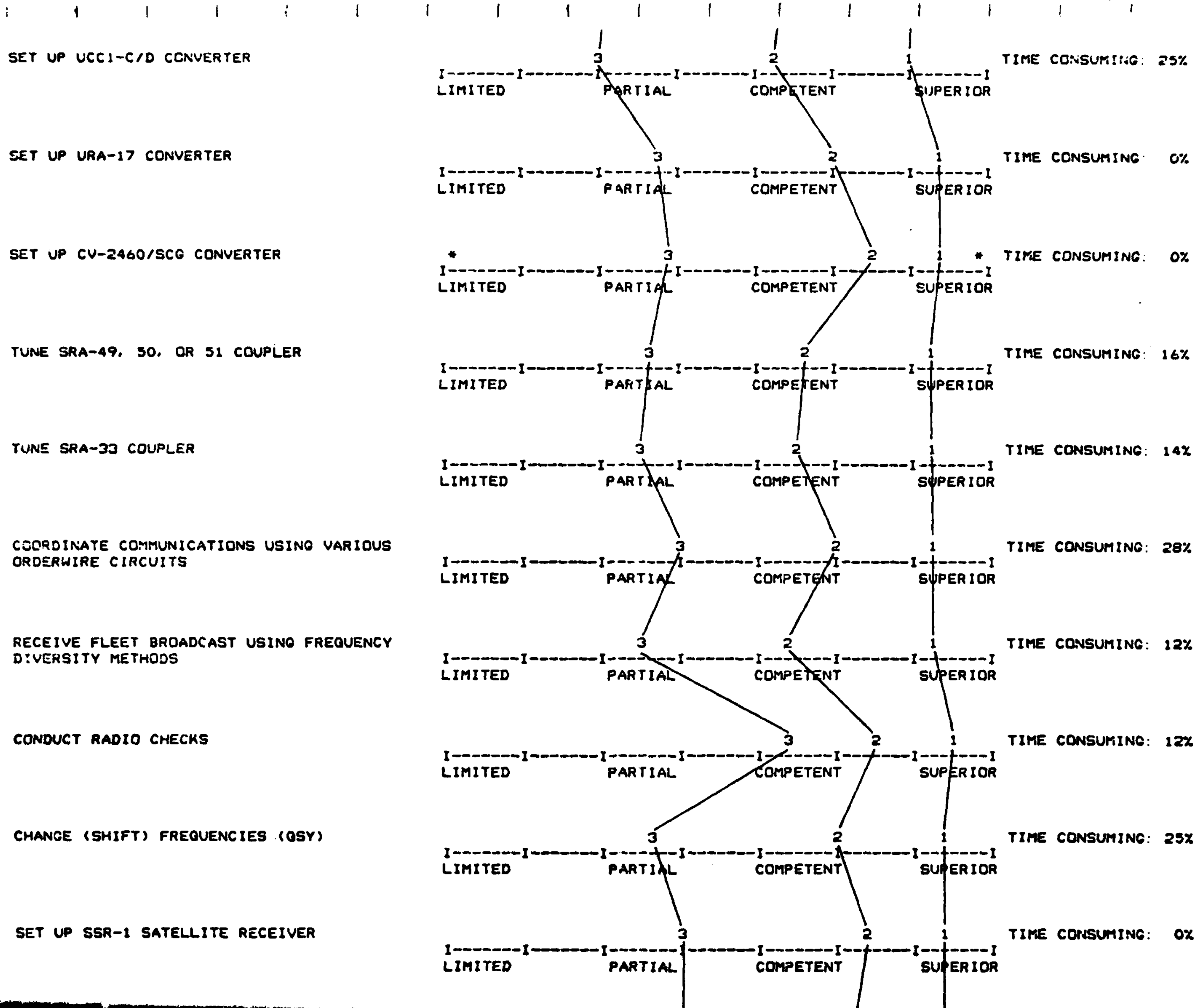
RM: MISCELLANEOUS SYSTEM OPERATIONS

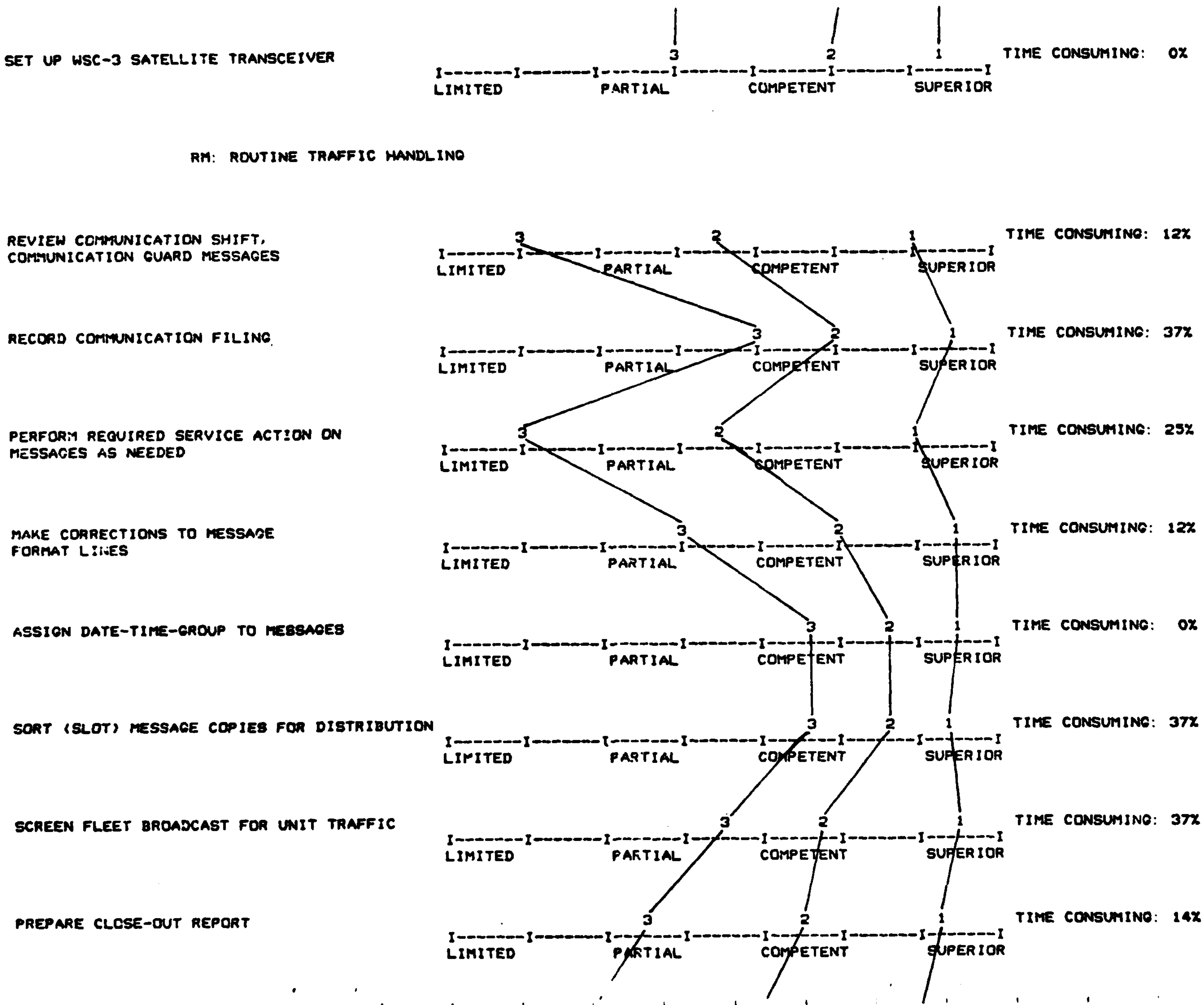
CHECK FREQUENCIES FOR USABILITY (QAP) — TIME CONSUMING: 50%

MONITOR RADIO CIRCUITS FOR RELIABILITY — TIME CONSUMING: 37%

TUNE TRANSCEIVERS — TIME CONSUMING: 12%




SET UP UCC1-C/D CONVERTER
LIMITED PARTIAL COMPETENT SUPERIOR
TIME CONSUMING: 25%
SET UP URA-17 CONVERTER
TIME CONSUMING: 0%
SET UP CV-2460/SCG CONVERTER
TIME CONSUMING: 0%
TUNE SRA-49, 50, OR 51 COUPLER
TIME CONSUMING: 16%
TUNE SRA-33 COUPLER
TIME CONSUMING: 14%
COORDINATE COMMUNICATIONS USING VARIOUS ORDERWIRE CIRCUITS
TIME CONSUMING: 28%
RECEIVE FLEET BROADCAST USING FREQUENCY DIVERSITY METHODS
TIME CONSUMING: 12%
CONDUCT RADIO CHECKS
TIME CONSUMING: 12%
CHANGE (SHIFT) FREQUENCIES (QSY)
TIME CONSUMING: 25%
SET UP SSR-1 SATELLITE RECEIVER
TIME CONSUMING: 0%


SET UP WSC-3 SATELLITE TRANSCEIVER
3 2 1
LIMITED PARTIAL COMPETENT SUPERIOR
TIME CONSUMING: 0%
RM: ROUTINE TRAFFIC HANDLING
REVIEW COMMUNICATION SHIFT, COMMUNICATION GUARD MESSAGES
TIME CONSUMING: 12%
RECORD COMMUNICATION FILING
TIME CONSUMING: 37%
PERFORM REQUIRED SERVICE ACTION ON MESSAGES AS NEEDED
TIME CONSUMING: 25%
MAKE CORRECTIONS TO MESSAGE FORMAT LINES
TIME CONSUMING: 12%
ASSIGN DATE-TIME-GROUP TO MESSAGES
TIME CONSUMING: 0%
SORT (SLOT) MESSAGE COPIES FOR DISTRIBUTION
TIME CONSUMING: 37%
SCREEN FLEET BROADCAST FOR UNIT TRAFFIC
TIME CONSUMING: 37%
PREPARE CLOSE-OUT REPORT
TIME CONSUMING: 14%

USE TRACER PROCEDURES WHEN REQUIRED

3		2		1	TIME CONSUMING 14%

I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

RM: SECURITY

DESTROY CLASSIFIED MATERIAL — 3 2 1 — TIME CONSUMING: 37%

I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

DETECT, IDENTIFY AND REPORT INTRUSION, JAMMING, AND INTERFERENCE (MIJI) ON RADIO RECEIVING EQUIPMENT — 3 2 1 — TIME CONSUMING: 12%

I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

RM: TYPE "B" SECURE SIMPLEX TELETYPE (AFTS) SYSTEM

DETERMINE SHIP(S) AND/OR STATION(S) TO BE TERMINATED WITH (TYPE "B" SYSTEM) — 3 2 1 — TIME CONSUMING: 0%

I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

DETERMINE THE FREQUENCY TO BE USED (TYPE "B" SYSTEM) — 3 2 1 — TIME CONSUMING: 0%

I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

SELECT EQUIPMENTS TO BE USED (TYPE "B" SYSTEM) — 3 2 1 — TIME CONSUMING: 0%

I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

ENERGIZE SYSTEM COMPONENTS (TYPE "B" SYSTEM) — 3 2 1 — TIME CONSUMING: 14%

I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

INTERFACE THE SYSTEM BY MAKING REQUIRED PATCHES (TYPE "B" SYSTEM) — 3 2 1 — TIME CONSUMING: 42%

I--------I--------I--------I--------I--------I--------I--------I
LIMITED PARTIAL COMPETENT SUPERIOR

SET UP ASSOCIATED CRYPTO DEVICE (TYPE "B" SYSTEM)	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 0%
TUNE AND ADJUST SYSTEM COMPONENTS FOR OPTIMUM PERFORMANCE (TYPE "B" SYSTEM)	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 33%
PREPARE OUTGOING MESSAGES IN CORRECT FORMAT (TYPE "B" SYSTEM)	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 42%
TRANSMIT AND RECEIVE MESSAGES (TYPE "B" SYSTEM)	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 28%

RM: TYPE "C" SECURE DUPLEX TELETYPE (AFTS) SYSTEM

DETERMINE SHIP(S) AND/OR STATION(S) TO BE TERMINATED WITH (TYPE "C" SYSTEM)	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 0%
DETERMINE FREQUENCIES TO BE USED (TYPE "C" SYSTEM)	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 0%
SELECT EQUIPMENTS TO BE USED (TYPE "C" SYSTEM)	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 0%
ENERGIZE SYSTEM COMPONENTS (TYPE "C" SYSTEM)	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 0%
INTERFACE THE SYSTEM BY MAKING REQUIRED PATCHES (TYPE "C" SYSTEM)	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 28%

SET UP ASSOCIATED CRYPTO DEVICE
(TYPE "C" SYSTEM)
TIME CONSUMING: 0%

TUNE AND ADJUST SYSTEM COMPONENTS FOR
OPTIMUM PERFORMANCE
(TYPE "C" SYSTEM)
TIME CONSUMING: 42%

PREPARE OUTGOING MESSAGES IN
CORRECT FORMAT
(TYPE "C" SYSTEM)
TIME CONSUMING: 42%

TRANSMIT AND RECEIVE MESSAGES
(TYPE "C" SYSTEM)
TIME CONSUMING: 28%

RM: TYPE "D" SECURE SIMPLEX TELETYPE FSK SYSTEM

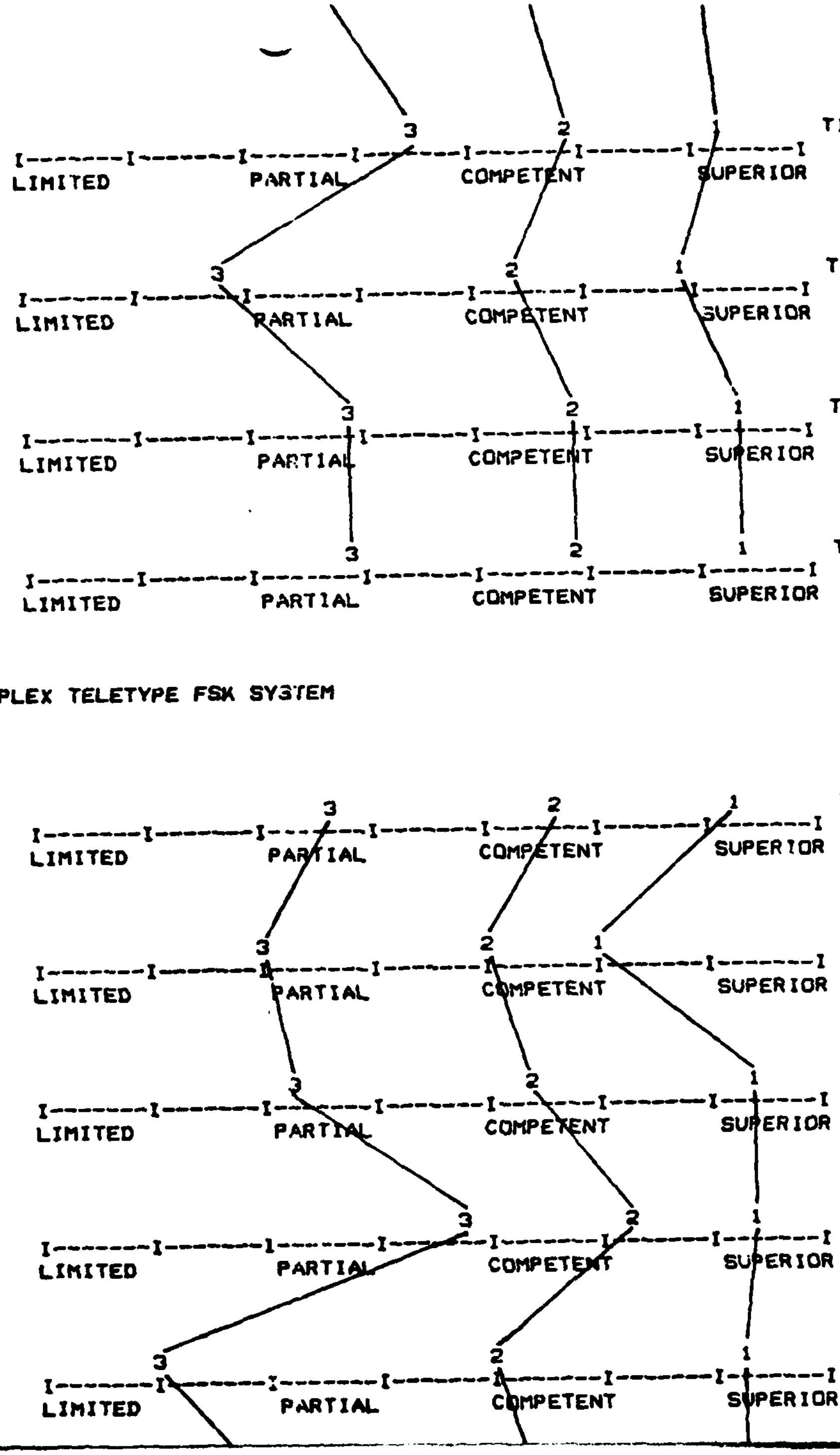
DETERMINE SHIP(S) AND/OR STATION(S) TO
BE TERMINATED WITH
(TYPE "D" SYSTEM)
TIME CONSUMING: 0%

DETERMINE THE FREQUENCY TO BE USED
(TYPE "D" SYSTEM)
TIME CONSUMING: 12%

SELECT EQUIPMENTS TO BE USED
(TYPE "D" SYSTEM)
TIME CONSUMING: 0%

ENERGIZE SYSTEM COMPONENTS
(TYPE "D" SYSTEM)
TIME CONSUMING: 0%

INTERFACE THE SYSTEM BY MAKING
REQUIRED PATCHES
(TYPE "D" SYSTEM)
TIME CONSUMING: 25%



SET UP ASSOCIATED CRYPTO DEVICE
(TYPE "D" SYSTEM)

```
                                      3              2              1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED           PARTIAL           COMPETENT         SUPERIOR
```

TIME CONSUMING: 0%

TUNE AND ADJUST SYSTEM COMPONENTS FOR
OPTIMUM PERFORMANCE
(TYPE "D" SYSTEM)

```
                              3                  2              1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED           PARTIAL           COMPETENT         SUPERIOR
```

TIME CONSUMING: 12%

PREPARE OUTGOING MESSAGES IN
CORRECT FORMAT
(TYPE "D" SYSTEM)

```
                               3                 2              1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED           PARTIAL           COMPETENT         SUPERIOR
```

TIME CONSUMING: 37%

TRANSMIT AND RECEIVE MESSAGES
(TYPE "D" SYSTEM)

```
                                   3                  2         1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED           PARTIAL           COMPETENT         SUPERIOR
```

TIME CONSUMING: 25%

RM: TYPE "G" SECURE DUPLEX TELETYPE (FSK) SYSTEM

DETERMINE SHIP(S) AND/OR STATION(S) TO
BE TERMINATED WITH
(TYPE "G" SYSTEM)

```
                            3                 2               1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED           PARTIAL           COMPETENT         SUPERIOR
```

TIME CONSUMING: 12%

DETERMINE THE FREQUENCIES TO BE USED
(TYPE "G" SYSTEM)

```
                            3                 2             1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED           PARTIAL           COMPETENT         SUPERIOR
```

TIME CONSUMING: 12%

SELECT EQUIPMENTS TO BE USED
(TYPE "G" SYSTEM)

```
                               3              2                 1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED           PARTIAL           COMPETENT         SUPERIOR
```

TIME CONSUMING: 12%

ENERGIZE SYSTEM COMPONENTS
(TYPE "G" SYSTEM)

```
                                   3                  2         1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED           PARTIAL           COMPETENT         SUPERIOR
```

TIME CONSUMING: 0%

INTERFACE THE SYSTEM BY MAKING
REQUIRED PATCHES
(TYPE "G" SYSTEM)

```
                         3                 2                1
I--------I--------I--------I--------I--------I--------I--------I
LIMITED           PARTIAL           COMPETENT         SUPERIOR
```

TIME CONSUMING: 25%

SET UP ASSOCIATED CRYPTO DEVICE
(TYPE "G" SYSTEM)

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 0%

TUNE AND ADJUST SYSTEM COMPONENTS FOR
OPTIMUM PERFORMANCE
(TYPE "G" SYSTEM)

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 37%

PREPARE OUTGOING MESSAGES IN CORRECT
FORMAT
(TYPE "G" SYSTEM)

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 37%

TRANSMIT AND RECEIVE MESSAGES
(TYPE "G" SYSTEM)

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 25%

RM: TYPE "N" SECURE MULTICHANNEL FLEET BROADCAST (HF)

DETERMINE AREA BROADCAST TO BE COPIED
(TYPE "N" (HF) SYSTEM)

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 0%

DETERMINE THE CHANNELS TO BE COPIED
(TYPE "N" (HF) SYSTEM)

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 0%

DETERMINE THE STATIONS KEYING THE AREA
BROADCAST
(TYPE "N" (HF) SYSTEM)

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

TIME CONSUMING: 12%

DETERMINE THE FREQUENCIES KEYED BY
EACH STATION
(TYPE "N" (HF) SYSTEM)

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

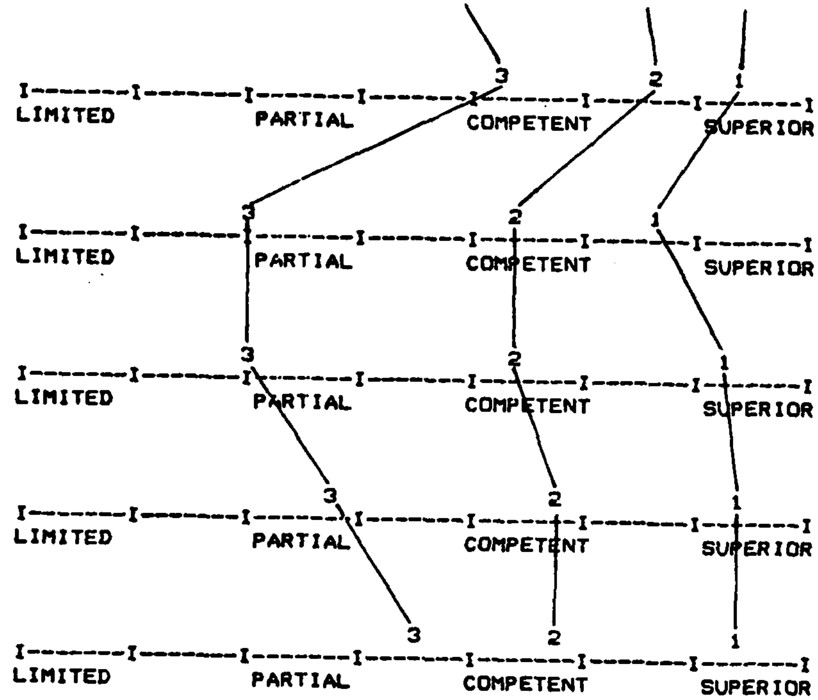
TIME CONSUMING: 12%

SELECT EQUIPMENTS TO BE USED
(TYPE "N" (HF) SYSTEM)

3 2 1
I-------I-------I-------I-------I-------I-------I-------I
LIMITED PARTIAL COMPETENT SUPERIOR

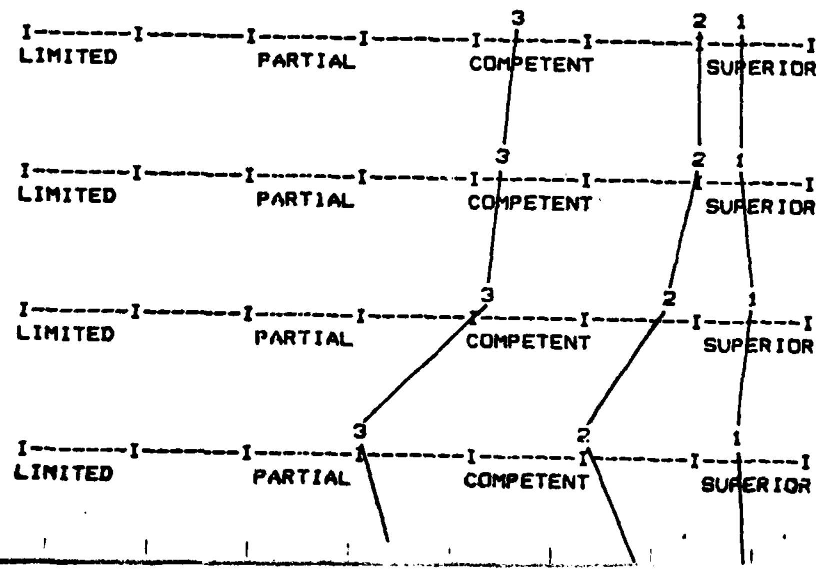
TIME CONSUMING: 12%

ENERGIZE SYSTEM COMPONENTS (TYPE "N" (HF) SYSTEM)	TIME CONSUMING: 12%
INTERFACE THE SYSTEM BY MAKING NECESSARY PATCHES (TYPE "N" (HF) SYSTEM)	TIME CONSUMING: 25%
TUNE AND ADJUST SYSTEM COMPONENTS FOR OPTIMUM PERFORMANCE (TYPE "N" (HF) SYSTEM)	TIME CONSUMING: 12%
SET UP ASSOCIATED CRYPTO DEVICES (TYPE "N" (HF) SYSTEM)	TIME CONSUMING: 12%
PROCESS INCOMING MESSAGES (TYPE "N" (HF) SYSTEM)	TIME CONSUMING: 37%



RM: TYPE "N" SECURE MULTICHANNEL FLEET BROADCAST (SATELLITE)

DETERMINE AREA BROADCAST TO BE COPIED (TYPE "N" (SATELLITE) SYSTEM)	TIME CONSUMING: 0%
DETERMINE THE CHANNELS TO BE COPIED (TYPE "N" (SATELLITE) SYSTEM)	TIME CONSUMING: 0%
DETERMINE THE STATIONS KEYING THE AREA BROADCAST (TYPE "N" (SATELLITE) SYSTEM)	TIME CONSUMING: 14%
DETERMINE THE FREQUENCIES KEYED BY EACH STATION (TYPE "N" (SATELLITE) SYSTEM)	TIME CONSUMING: 0%



Task	Scale	Time consuming
SELECT EQUIPMENTS TO BE USED (TYPE "N" (SATELLITE) SYSTEM)	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 0%
ENERGIZE SYSTEM COMPONENTS (TYPE "N" (SATELLITE) SYSTEM)	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 0%
INTERFACE THE SYSTEM BY MAKING NECESSARY PATCHES (TYPE "N" (SATELLITE) SYSTEM)	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 14%
TUNE AND ADJUST SYSTEM COMPONENTS FOR OPTIMUM PERFORMANCE (TYPE "N" (SATELLITE) SYSTEM)	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 14%
SET UP ASSOCIATED CRYPTO DEVICES (TYPE "N" (SATELLITE) SYSTEM)	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 14%
PROCESS INCOMING MESSAGES (TYPE "N" (SATELLITE) SYSTEM)	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 42%

RM: TYPE "R" SECURE WIDEBAND VOICE SYSTEM

Task	Scale	Time consuming
DETERMINE COMMUNICATION NET SUBSCRIBERS (TYPE "R" SYSTEM)	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 12%
DETERMINE FREQUENCY TO BE USED (TYPE "R" SYSTEM)	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 12%
SELECT EQUIPMENTS TO BE USED (TYPE "R" SYSTEM)	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 0%

Task	LIMITED		PARTIAL		COMPETENT		SUPERIOR	Time consuming
ENERGIZE SYSTEM COMPONENTS (TYPE "R" SYSTEM)				3		2	1	TIME CONSUMING: 0%
INTERFACE THE SYSTEMS BY MAKING REQUIRED PATCHES (TYPE "R" SYSTEM)			3		2		1	TIME CONSUMING: 12%
SET UP ASSOCIATED CRYPTO DEVICES (TYPE "R" SYSTEM)				3	2		1	TIME CONSUMING: 37%
TUNE AND ADJUST SYSTEM COMPONENTS FOR OPTIMUM PERFORMANCE (TYPE "R" SYSTEM)			3		2		1	TIME CONSUMING: 25%
TRANSMIT AND RECEIVE INTELLIGENCE LOCALLY (TYPE "R" SYSTEM)				3		2	1	TIME CONSUMING: 12%
INTERFACE SYSTEM FOR REMOTE OPERATION (TYPE "R" SYSTEM)			3			2	1	TIME CONSUMING: 0%

RM: TYPE "U" NONSECURE WIDEBAND VOICE SYSTEM

Task	LIMITED		PARTIAL		COMPETENT		SUPERIOR	Time consuming
DETERMINE COMMUNICATIONS NET SUBSCRIBERS (TYPE "U" SYSTEM)				3		2	1	TIME CONSUMING: 12%
DETERMINE FREQUENCY TO BE USED (TYPE "U" SYSTEM)				3		2	1	TIME CONSUMING: 0%
SELECT EQUIPMENTS TO BE USED (TYPE "U" SYSTEM)			3		2		1	TIME CONSUMING: 0%

ENERGIZE SYSTEM COMPONENTS (TYPE "U" SYSTEM)
I-------I-------I-------I-------I-------I-------I-------I
LIMITED — PARTIAL — COMPETENT — SUPERIOR
TIME CONSUMING: 0%

PATCH RECEIVER AND TRANSMITTER TO ASSOCIATED ANTENNA (TYPE "U" SYSTEM)
I-------I-------I-------I-------I-------I-------I-------I
LIMITED — PARTIAL — COMPETENT — SUPERIOR
TIME CONSUMING: 0%

TUNE AND ADJUST SYSTEM COMPONENTS FOR OPTIMUM PERFORMANCE (TYPE "U" SYSTEM)
I-------I-------I-------I-------I-------I-------I-------I
LIMITED — PARTIAL — COMPETENT — SUPERIOR
TIME CONSUMING: 12%

TRANSMIT AND RECEIVE INTELLIGENCE LOCALLY (TYPE "U" SYSTEM)
I-------I-------I-------I-------I-------I-------I-------I
LIMITED — PARTIAL — COMPETENT — SUPERIOR
TIME CONSUMING: 25%

INTERFACE SYSTEM FOR REMOTE OPERATION (TYPE "U" SYSTEM)
I-------I-------I-------I-------I-------I-------I-------I
LIMITED — PARTIAL — COMPETENT — SUPERIOR
TIME CONSUMING: 0%

RM: TYPE "Y" NONSECURE NARROWBAND VOICE SYSTEM

DETERMINE COMMUNICATION NET SUBSCRIBERS (TYPE "Y" SYSTEM)
I-------I-------I-------I-------I-------I-------I-------I
LIMITED — PARTIAL — COMPETENT — SUPERIOR
TIME CONSUMING: 14%

DETERMINE FREQUENCY TO BE USED (TYPE "Y" SYSTEM)
I-------I-------I-------I-------I-------I-------I-------I
LIMITED — PARTIAL — COMPETENT — SUPERIOR
TIME CONSUMING: 0%

SELECT EQUIPMENTS TO BE USED (TYPE "Y" SYSTEM)
I-------I-------I-------I-------I-------I-------I-------I
LIMITED — PARTIAL — COMPETENT — SUPERIOR
TIME CONSUMING: 0%

ENERGIZE SYSTEM COMPONENTS (TYPE "Y" SYSTEM)
I-------I-------I-------I-------I-------I-------I-------I
LIMITED — PARTIAL — COMPETENT — SUPERIOR
TIME CONSUMING: 0%

```
                                                                      3              2        1
PATCH RECEIVER AND TRANSMITTER TO          I-------I-------I-------I-+------I-------I+------I-+-----I   TIME CONSUMING:  0%
ASSOCIATED ANTENNA                         LIMITED         PARTIAL          COMPETENT       SUPERIOR
(TYPE "Y" SYSTEM)

                                                                      3              2        1
TUNE AND ADJUST SYSTEM COMPONENTS FOR      I-------I-------I-------I-+------I-------I+------I-+-----I   TIME CONSUMING: 28%
OPTIMUM PERFORMANCE                        LIMITED         PARTIAL          COMPETENT       SUPERIOR
(TYPE "Y" SYSTEM)

                                                                         3           2        1
TRANSMIT AND RECEIVE INTELLIGENCE LOCALLY  I-------I-------I-------I------+-I-------I-+-----I--+----I   TIME CONSUMING: 14%
(TYPE "Y" SYSTEM)                          LIMITED         PARTIAL          COMPETENT       SUPERIOR

                                                                      3              2        1
INTERFACE SYSTEM FOR REMOTE OPERATION      I-------I-------I-------I-------I-------I-------I-------I   TIME CONSUMING:  0%
(TYPE "Y" SYSTEM)                          LIMITED         PARTIAL          COMPETENT       SUPERIOR
```

INDEX OF TASKS PERFORMED BY STGs

ST: GENERAL OPERATION

SELECTS OPTIMUM OPERATING MODES IN VIEW OF SVP AND OTHER ENVIRONMENTAL FACTORS — TIME CONSUMING: 6% SQS-35 SQS-26 SQS-23

CONDUCTS ACTIVE SEARCH USING ALL CONTROLS OPTIMALLY — TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23

DETECTS TRANSISTORY SIGNALS WITH LOW S/N RATIOS — TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23

ESTIMATES TARGET DOPPLER USING DOPPLER DISPLAY — TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23

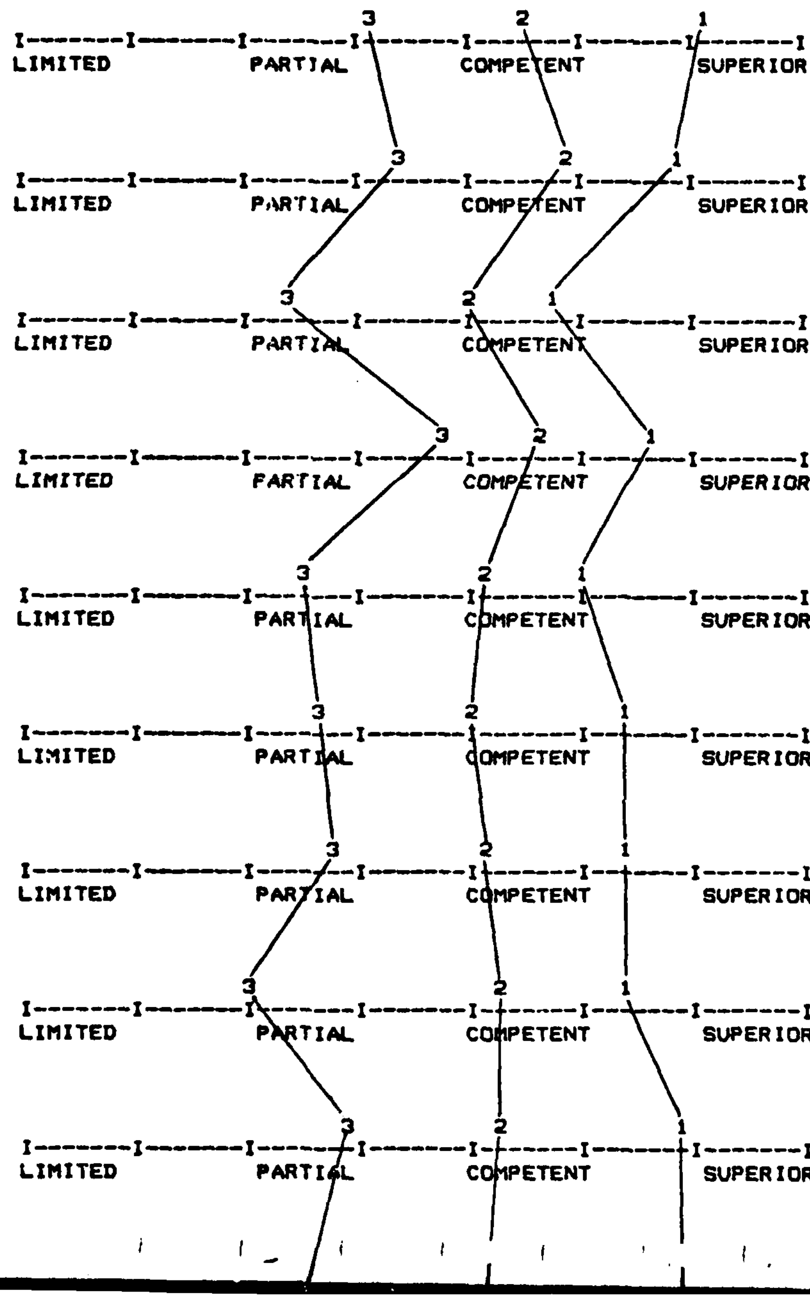
PERFORMS TARGET MOTION ANALYSIS — TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23

TRACKS MORE THAN 1 TARGET SIMULTANEOUSLY — TIME CONSUMING: 10% SQS-35 SQS-26 SQS-23

PERCEIVES CHANGES IN TARGET SIGNAL INDICATING CHANGES IN TARGET STATUS — TIME CONSUMING: 6% SQS-35 SQS-26 SQS-23

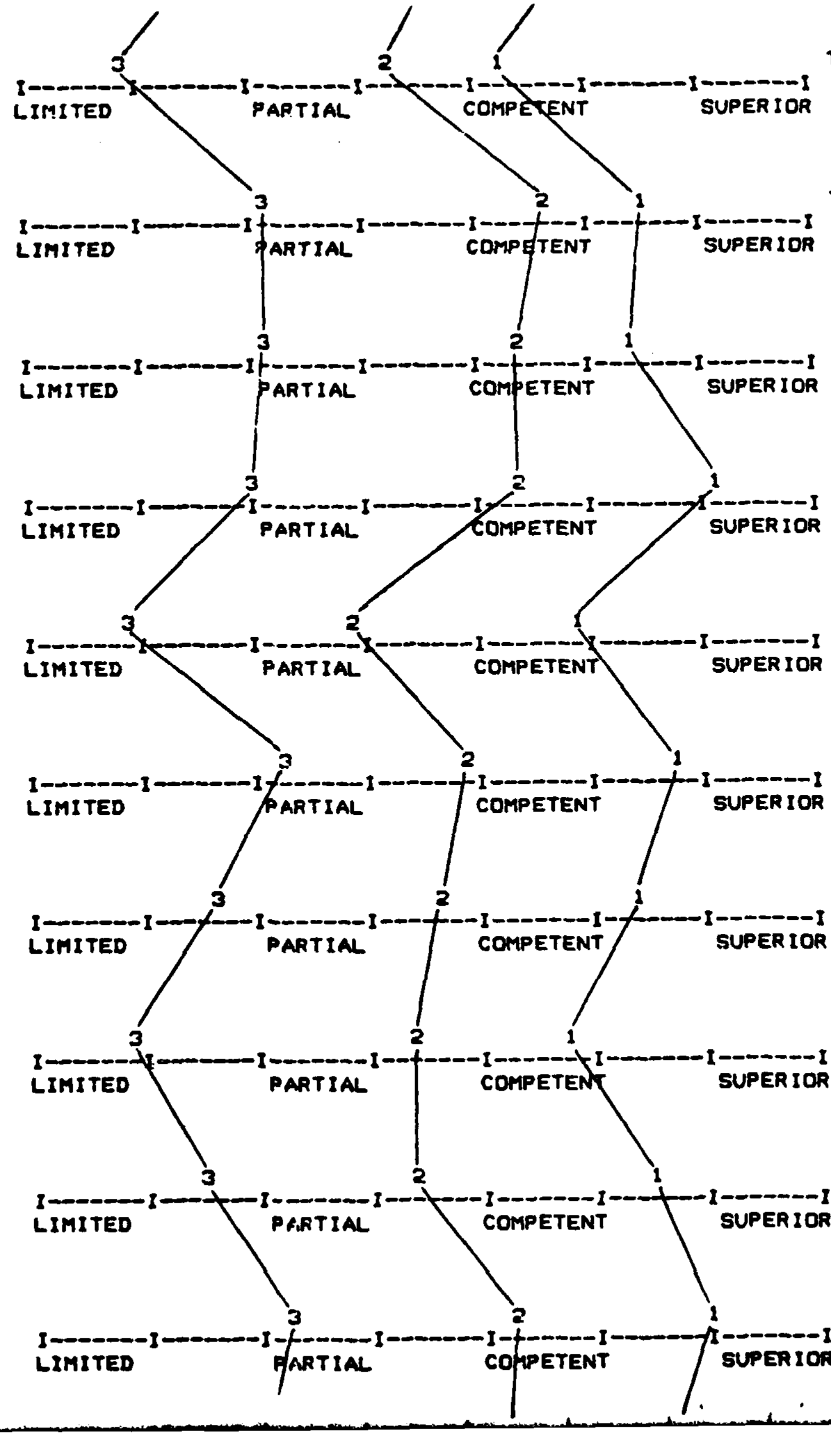
INTERPRETS CHANGES IN SIGNAL PRESENTATION AS A FUNCTION OF TRANSMISSION AND RECEIVER CONTROL SETTINGS — TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23

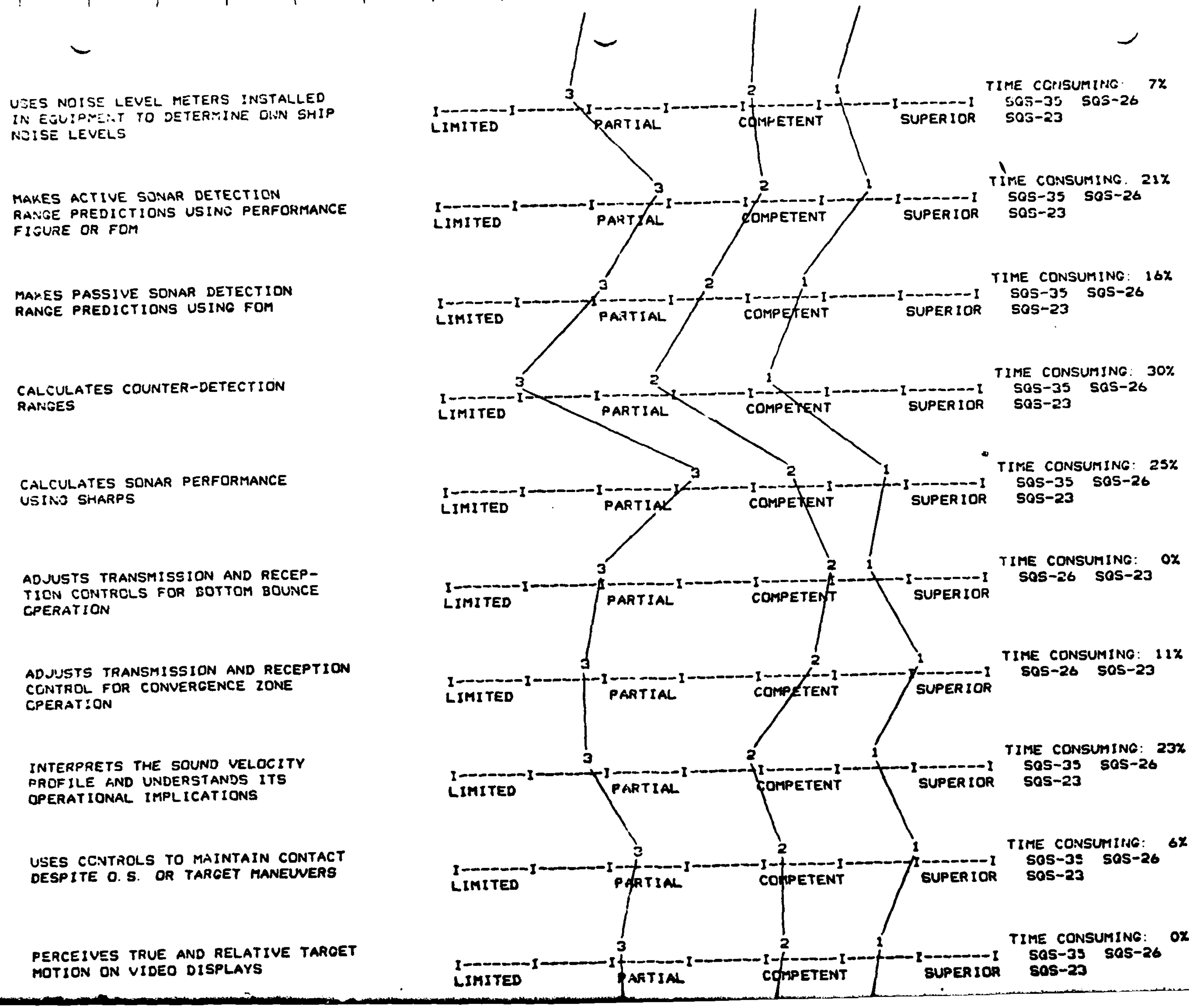
DIFFERENTIATES TARGET SIGNALS FROM REVERBERATION AND NOISE — TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23



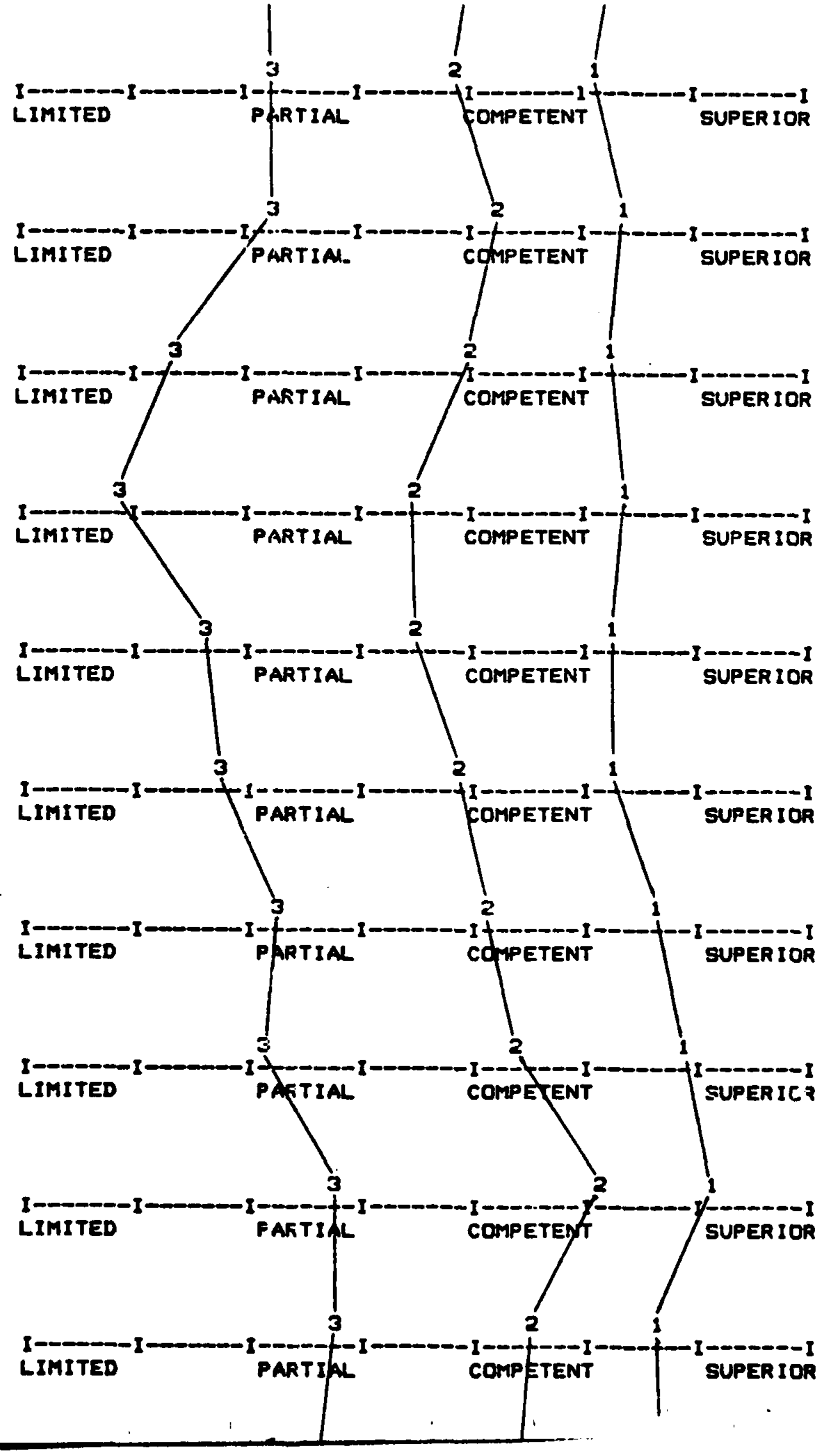
RELATES INFORMATION FROM ALL AVAILABLE SOURCES IN CLASSIFYING TARGET	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 35% SQS-35 SQS-26 SQS-23
DIFFERENTIATES SUBMARINE FROM NON-SUBMARINE TARGETS	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 13% SQS-35 SQS-26 SQS-23
COORDINATES ACTIVITIES OF ALL SONAR TEAM MEMBERS	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 13% SQS-35 SQS-26 SQS-23
MAKES ALL NECESSARY AND DESIRABLE REPORTS TO APPROPRIATE HIGHER-LEVEL PERSONNEL	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 13% SQS-35 SQS-26 SQS-23
PERFORMS DETECTION OF PASSIVE SONAR CONTACTS BY BEARING TIME RECORDER (BTR) TRACES	* LIMITED — PARTIAL — COMPETENT — SUPERIOR *	TIME CONSUMING: 0% SQS-35 SQS-26
DETECTS AND IDENTIFIES TARGET MANEUVERS	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 20% SQS-35 SQS-26 SQS-23
RECOMMENDS SONAR OPERATING MODES DURING CONTACT PROSECUTION	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23
RECOMMENDS TOW DEPTHS FOR TOWED SENSORS TO AID IN SEARCH FOR AND PROSECUTION OF SONAR CONTACTS	* LIMITED — PARTIAL — COMPETENT — SUPERIOR *	TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23
RECOMMENDS CHANGES OF COURSE AND SPEED OF OWN SHIP DURING PROSECUTION OF A SONAR CONTACT	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23
MAKES RECOMMENDATIONS TO BRIDGE/CONN/CIC TO CLEAR BAFFLES	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23

Task	Time consuming	Sonar
RECOMMENDS USE OF PRAIRIE MASKER SECURING NOISY EQUIPMENTS, AND ADJUSTMENTS IN MANEUVERING TO REDUCE DETECTABILITY	TIME CONSUMING: 18%	SQS-35 SQS-26 SQS-23
USES TARGET PLOT ON UNDERWATER WEAPONS FIRE CONTROL SYSTEM (UWFCS) TO DETERMINE TARGET COURSE, SPEED AND TRACK CONFIDENCE	TIME CONSUMING: 7%	SQS-35 SQS-26 SQS-23
RECOMMENDS WEAPON SELECTION AND SETTING DURING AN ANTISUBMARINE WARFARE (ASW) ATTACK OR SIMULATED ATTACK	TIME CONSUMING: 0%	SQS-35 SQS-26 SQS-23
RECOMMENDS SEARCH ARCS BASED ON UWFCS PLOT WHEN SONAR IS NOT IN CONTACT	TIME CONSUMING: 0%	SQS-35 SQS-26 SQS-23
CONNS THE SHIP FROM UNDERWATER BATTERY (UB) PLOT DURING AN ASW ATTACK OR SIMULATED ASW ATTACK	TIME CONSUMING: 7%	SQS-35 SQS-26 SQS-23
ANALYZES XBT/BSH AND OTHER OCEANOGRAPHIC (OCEANO) METEOROLOGICAL (MET) DATA	TIME CONSUMING: 30%	SQS-35 SQS-26 SQS-23
CALCULATES ACTIVE :NAR FIGURE OF MERIT (FOM)	TIME CONSUMING: 28%	SQS-35 SQS-26 SQS-23
CALCULATES PASSIVE FOM	TIME CONSUMING: 9%	SQS-35 SQS-26 SQS-23
USES PUBLICATIONS CONCERNING OCEANOGRAPHIC AND METEOROLOGICAL CONDITIONS TO DETERMINE THE BEST PROPAGATION PATH TO UTILIZE (SUCH AS DIRECT, BOTTOM REFLECTED, CONVERGENCE ZONE)	TIME CONSUMING: 16%	SQS-35 SQS-26 SQS-23
CALCULATES BEST DEPTH FOR SUBMARINE TO AVOID DETECTION	TIME CONSUMING: 7%	SQS-35 SQS-26 SQS-23




USES NOISE LEVEL METERS INSTALLED IN EQUIPMENT TO DETERMINE OWN SHIP NOISE LEVELS
LIMITED PARTIAL COMPETENT SUPERIOR
TIME CONSUMING: 7%
SQS-35 SQS-26
SQS-23
MAKES ACTIVE SONAR DETECTION RANGE PREDICTIONS USING PERFORMANCE FIGURE OR FOM
LIMITED PARTIAL COMPETENT SUPERIOR
TIME CONSUMING: 21%
SQS-35 SQS-26
SQS-23
MAKES PASSIVE SONAR DETECTION RANGE PREDICTIONS USING FOM
LIMITED PARTIAL COMPETENT SUPERIOR
TIME CONSUMING: 16%
SQS-35 SQS-26
SQS-23
CALCULATES COUNTER-DETECTION RANGES
LIMITED PARTIAL COMPETENT SUPERIOR
TIME CONSUMING: 30%
SQS-35 SQS-26
SQS-23
CALCULATES SONAR PERFORMANCE USING SHARPS
LIMITED PARTIAL COMPETENT SUPERIOR
TIME CONSUMING: 25%
SQS-35 SQS-26
SQS-23
ADJUSTS TRANSMISSION AND RECEPTION CONTROLS FOR BOTTOM BOUNCE OPERATION
LIMITED PARTIAL COMPETENT SUPERIOR
TIME CONSUMING: 0%
SQS-26 SQS-23
ADJUSTS TRANSMISSION AND RECEPTION CONTROL FOR CONVERGENCE ZONE OPERATION
LIMITED PARTIAL COMPETENT SUPERIOR
TIME CONSUMING: 11%
SQS-26 SQS-23
INTERPRETS THE SOUND VELOCITY PROFILE AND UNDERSTANDS ITS OPERATIONAL IMPLICATIONS
LIMITED PARTIAL COMPETENT SUPERIOR
TIME CONSUMING: 23%
SQS-35 SQS-26
SQS-23
USES CONTROLS TO MAINTAIN CONTACT DESPITE O.S. OR TARGET MANEUVERS
LIMITED PARTIAL COMPETENT SUPERIOR
TIME CONSUMING: 6%
SQS-35 SQS-26
SQS-23
PERCEIVES TRUE AND RELATIVE TARGET MOTION ON VIDEO DISPLAYS
LIMITED PARTIAL COMPETENT SUPERIOR
TIME CONSUMING: 0%
SQS-35 SQS-26
SQS-23

DETECTS TARGET SIGNALS EVEN THOUGH THEY MAY BE VERY WEAK OR MASKED BY NOISE	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 20% SQS-35 SQS-26 SQS-23
DETERMINES TARGET COURSE AND SPEED FROM PLOT	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 8% SQS-35 SQS-26 SQS-23
CORRELATES OWN SHIP SONAR DATUM WITH DATA FROM OUTSIDE SOURCES	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 25% SQS-35 SQS-26 SQS-23
ESTIMATES PROBABLE LOCATIONS OF LOST CONTACTS USING TIME-LATE AND FINAL CONTACT DATA	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 9% SQS-35 SQS-26 SQS-23
DISTINGUISHES BETWEEN MOVING AND NON-MOVING TARGETS USING THE SONAR DISPLAYS ONLY	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 13% SQS-35 SQS-26 SQS-23
DISTINGUISHES MARINE LIFE OR OTHER NON-SUBMARINE CONTACTS FROM SUBMARINE CONTACTS	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING 13% SQS-35 SQS 26 SQS-23
UNDERSTANDS MEANING AND RELIABILITY OF AUDIO CLUES IN CLASSIFYING THE TARGET	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 13% SQS-35 SQS-26 SQS-23
UNDERSTANDS MEANING AND RELIABILITY OF VIDEO CLUES IN CLASSIFYING THE TARGET	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 7% SQS-35 SQS-26 SQS-23
RECOGNIZES EVIDENCE OF TORPEDO ATTACK	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23
RECOGNIZES HOW TARGET SIGNAL CAN VARY IN APPEARANCE WITH TARGET RANGE, TARGET ASPECT, TARGET DEPTH	I-------I-------I-------I-------I-------I-------I-------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 13% SQS-35 SQS-26 SQS-23



RECOGNIZES HOW TARGET SIGNAL CAN VARY IN APPEARANCE WITH MODE OF TRANSMISSION, POWER LEVEL, PULSE TYPE	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23

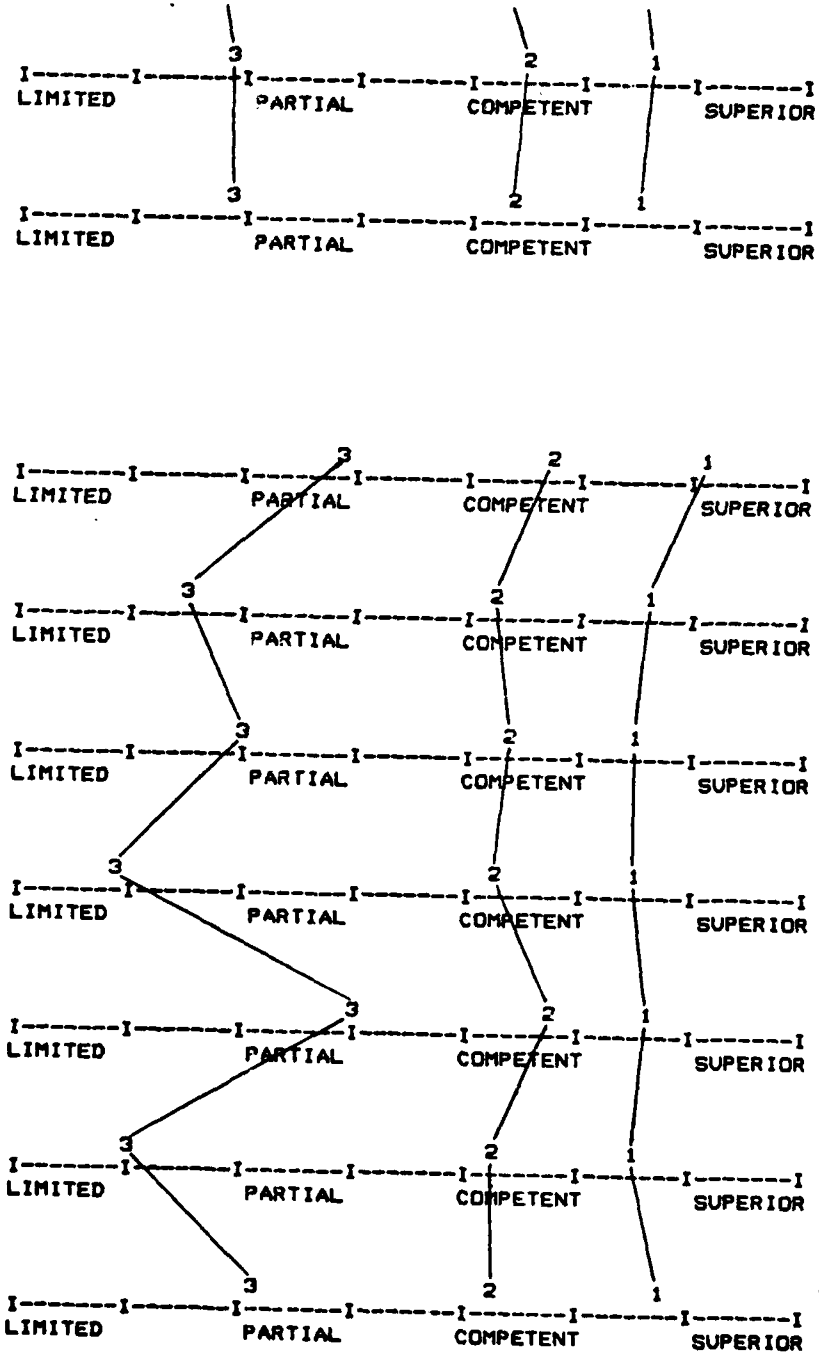
ST: GENERAL MAINTENANCE

RESEARCH TECHNICAL PUBLICATIONS TO FIND APPROPRIATE SCHEMATICS/LOGIC DIAGRAMS/TABLES/TROUBLESHOOTING CHARTS/MAINTENANCE INFORMATION/PART NUMBERS FOR SPECIFIC PIECES OF EQUIPMENT	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 27% SQS-35 SQS-26 SQS-23
IDENTIFY STANDARD ELECTRONIC/MECHANICAL SYMBOLS AS USED ON SCHEMATICS, LOGIC DIAGRAMS, FLOW CHARTS, ETC.	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23
MODIFY EQUIPMENT IN ACCORDANCE WITH SHIPALTS, ORDALTS, FIELD CHANGE ORDERS AND ELECTRONIC INFORMATION BULLETINS (EIBS)	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 23% SQS-35 SQS-26 SQS-23
CHANGE SYSTEM CONFIGURATION BY PATCHING OR BY SWITCHBOARD CHANGES	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 33% SQS-35 SQS-26 SQS-23
ANALYZE EQUIPMENT FRONT PANEL INDICATORS FOR FAULT DETECTION	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 11% SQS-35 SQS-26 SQS-23
USE TEST EQUIPMENT TO INJECT SIGNALS AND/OR TAKE READINGS	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 11% SQS-35 SQS-26 SQS-23
ASSEMBLE/REPAIR CABLES AND TEST LEADS, SUCH AS CONNECTORS, PROBES, ETC.	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 17% SQS-35 SQS-26 SQS-23
ALIGN/ADJUST MECHANICAL LINKAGES AND GEAR TRAINS	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING: 37% SQS-35 SQS-26 SQS-23

LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A SUBSYSTEM	TIME CONSUMING: 11% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A UNIT	TIME CONSUMING: 16% SQS-35 SQS-26 SQS-23

ST: AF AMPLIFIER

CLEAN AF AMPLIFIER	TIME CONSUMING: 13% SQS-35 SQS-26 SQS-23
TEST/INSPECT AF AMPLIFIER	TIME CONSUMING: 20% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE AF AMPLIFIER MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 15% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE AF AMPLIFIER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 35% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE AF AMPLIFIER MODULES/CARDS	TIME CONSUMING: 15% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE AF AMPLIFIER COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSITORS, ICS, ETC.	TIME CONSUMING: 41% SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST AF AMPLIFIER	TIME CONSUMING: 18% SQS-35 SQS-26 SQS-23



ST: AMPLIFIER-MODULATOR

	LIMITED / PARTIAL / COMPETENT / SUPERIOR	
CLEAN SONAR AMPLIFIER-MODULATOR	* 3 2 1 *	TIME CONSUMING: 0% SQS-26 SQS-23
TEST/INSPECT SONAR AMPLIFIER-MODULATOR	3 2 1	TIME CONSUMING: 0% SQS-26 SQS-23
LOCALIZE/ISOLATE SONAR AMPLIFIER-MODULATOR MALFUNCTION TO THE MODULE/CARD LEVEL	3 2 1	TIME CONSUMING: 0% SQS-26 SQS-23
LOCALIZE/ISOLATE SONAR AMPLIFIER-MODULATOR MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3 2 1	TIME CONSUMING: 0% SQS-26 SQS-23
REMOVE/REPLACE SONAR AMPLIFIER-MODULATOR MODULES/CARDS	3 2 1	TIME CONSUMING: 0% SQS-26 SQS-23
REMOVE/REPLACE SONAR AMPLIFIER-MODULATOR COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3 2 1	TIME CONSUMING: 16% SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST SONAR AMPLIFIER-MODULATOR	3 2 1	TIME CONSUMING: 0% SQS-26 SQS-23

ST: AMPLIFIER-SCANNER

	LIMITED / PARTIAL / COMPETENT / SUPERIOR	
CLEAN SONAR AMPLIFIER-SCANNER	3 2 1	TIME CONSUMING: 45% SQS-35 SQS-26 SQS-23

```
TEST/INSPECT SONAR AMPLIFIER-SCANNER
                                                  3                        2       1
                                       I-------I-------I-------I-------I-------I-------I-------I   TIME CONSUMING: 15%
                                       LIMITED         PARTIAL         COMPETENT       SUPERIOR      SQS-35  SQS-26
                                                                                                     SQS-23

LOCALIZE/ISOLATE SONAR AMPLIFIER-SCANNER          3                      2       1
MALFUNCTION TO THE MODULE/CARD LEVEL   I-------I-------I-------I-------I-------I-------I-------I   TIME CONSUMING: 15%
                                       LIMITED         PARTIAL         COMPETENT       SUPERIOR      SQS-35  SQS-26
                                                                                                     SQS-23

LOCALIZE/ISOLATE SONAR AMPLIFIER-SCANNER          3                        2       1
MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS I-------I-------I-------I-------I-------I-------I-------I   TIME CONSUMING: 25%
SWITCHES, RESISTORS, CAPACITORS, TRAN-  LIMITED         PARTIAL         COMPETENT       SUPERIOR      SQS-35  SQS-26
SISTORS, ICS, ETC.                                                                                   SQS-23

REMOVE/REPLACE SONAR AMPLIFIER-SCANNER                           3       2       1
MODULES/CARDS                          I-------I-------I-------I-------I-------I-------I-------I   TIME CONSUMING: 16%
                                       LIMITED         PARTIAL         COMPETENT       SUPERIOR      SQS-35  SQS-26
                                                                                                     SQS-23

REMOVE/REPLACE SONAR AMPLIFIER-                    3                       2       1
SCANNER COMPONENTS, SUCH AS SWITCHES,  I-------I-------I-------I-------I-------I-------I-------I   TIME CONSUMING: 25%
RESISTORS, CAPACITORS, TRANSISTORS,    LIMITED         PARTIAL         COMPETENT       SUPERIOR      SQS-35  SQS-26
ICS, ETC.                                                                                            SQS-23

CALIBRATE/ALIGN/ADJUST SONAR                       3                      2        1
AMPLIFIER-SCANNER                      I-------I-------I-------I-------I-------I-------I-------I   TIME CONSUMING: 25%
                                       LIMITED         PARTIAL         COMPETENT       SUPERIOR      SQS-35  SQS-26
                                                                                                     SQS-23
```

ST: CONSOLE 1/CONTROL INDICATOR

```
CLEAN/LUBRICATE CONSOLE 1/CONTROL                      3                 2        1
INDICATOR                              I-------I-------I-------I-------I-------I-------I-------I   TIME CONSUMING: 29%
                                       LIMITED         PARTIAL         COMPETENT       SUPERIOR      SQS-35  SQS-26
                                                                                                     SQS-23

TEST/INSPECT CONSOLE 1/CONTROL                       3                   2       1
INDICATOR                              I-------I-------I-------I-------I-------I-------I-------I   TIME CONSUMING: 22%
                                       LIMITED         PARTIAL         COMPETENT       SUPERIOR      SQS-35  SQS-26
                                                                                                     SQS-23

LOCALIZE/ISOLATE CONSOLE 1/CONTROL             3                        2       1
INDICATOR MALFUNCTION TO THE           I-------I-------I-------I-------I-------I-------I-------I   TIME CONSUMING: 14%
MODULE/CARD LEVEL                      LIMITED         PARTIAL         COMPETENT       SUPERIOR      SQS-35  SQS-26
                                                                                                     SQS-23
```

LOCALIZE/ISOLATE CONSOLE 1/CONTROL INDICATOR MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

TIME CONSUMING: 29%
SQS-35 SQS-26
SQS-23

REMOVE/REPLACE CONSOLE 1/CONTROL INDICATOR MODULES/CARDS

TIME CONSUMING: 20%
SQS-35 SQS-26
SQS-23

REMOVE/REPLACE CONSOLE 1/CONTROL INDICATOR COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

TIME CONSUMING: 27%
SQS-35 SQS-26
SQS-23

CALIBRATE/ALIGN/ADJUST CONSOLE 1/ CONTROL INDICATOR

TIME CONSUMING: 38%
SQS-35 SQS-26
SQS-23

ST: CONSOLE 2/CONTROL INDICATOR

CLEAN/LUBRICATE CONSOLE 2

TIME CONSUMING: 22%
SQS-35 SQS-26
SQS-23

TEST/INSPECT CONSOLE 2

TIME CONSUMING: 10%
SQS-35 SQS-26
SQS-23

LOCALIZE/ISOLATE CONSOLE 2 MAL-FUNCTION TO THE MODULE/CARD LEVEL

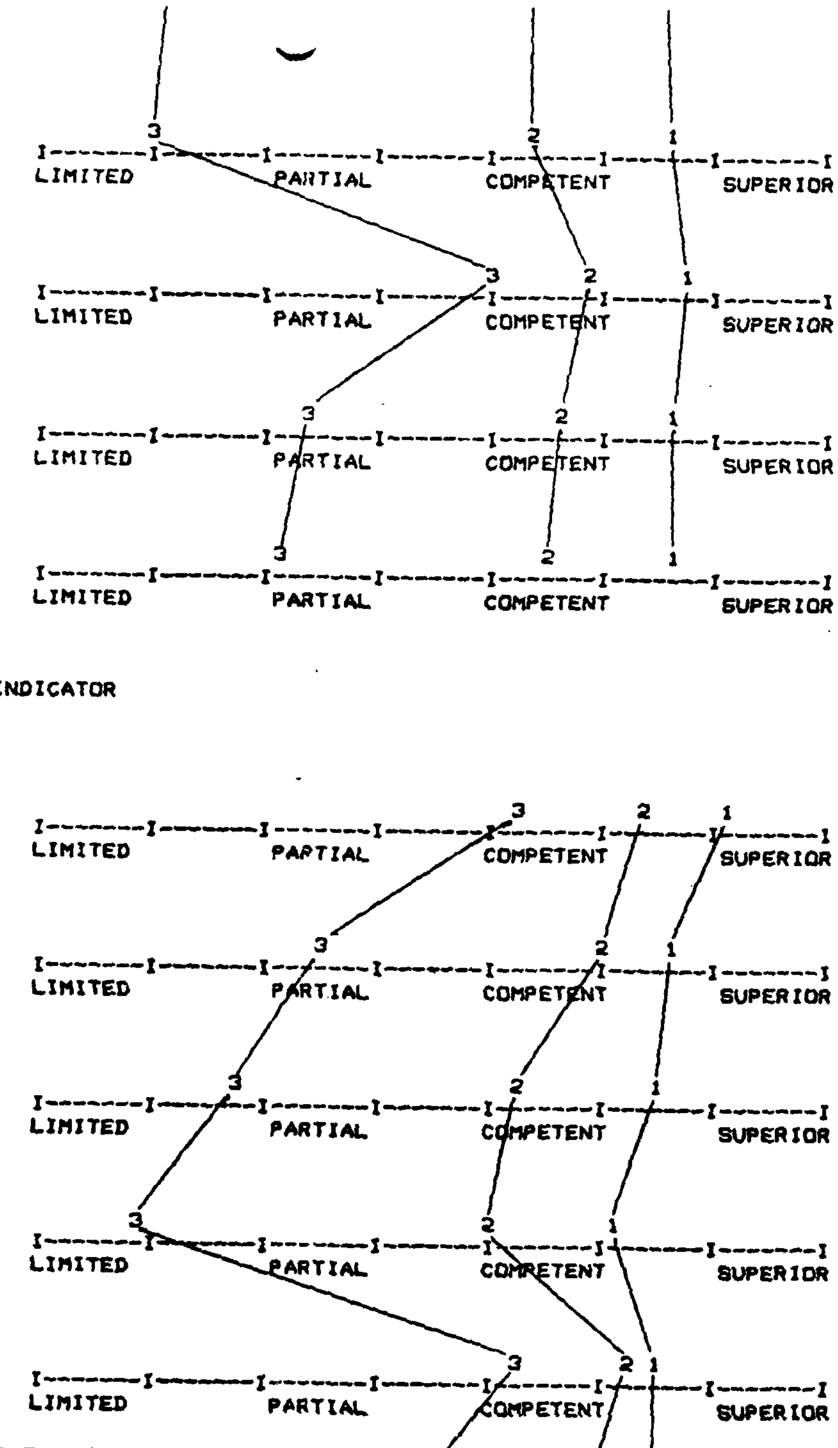
TIME CONSUMING: 0%
SQS-35 SQS-26
SQS-23

LOCALIZE/ISOLATE CONSOLE 2 MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

TIME CONSUMING: 10%
SQS-35 SQS-26
SQS-23

REMOVE/REPLACE CONSOLE 2 MODULES/CARDS

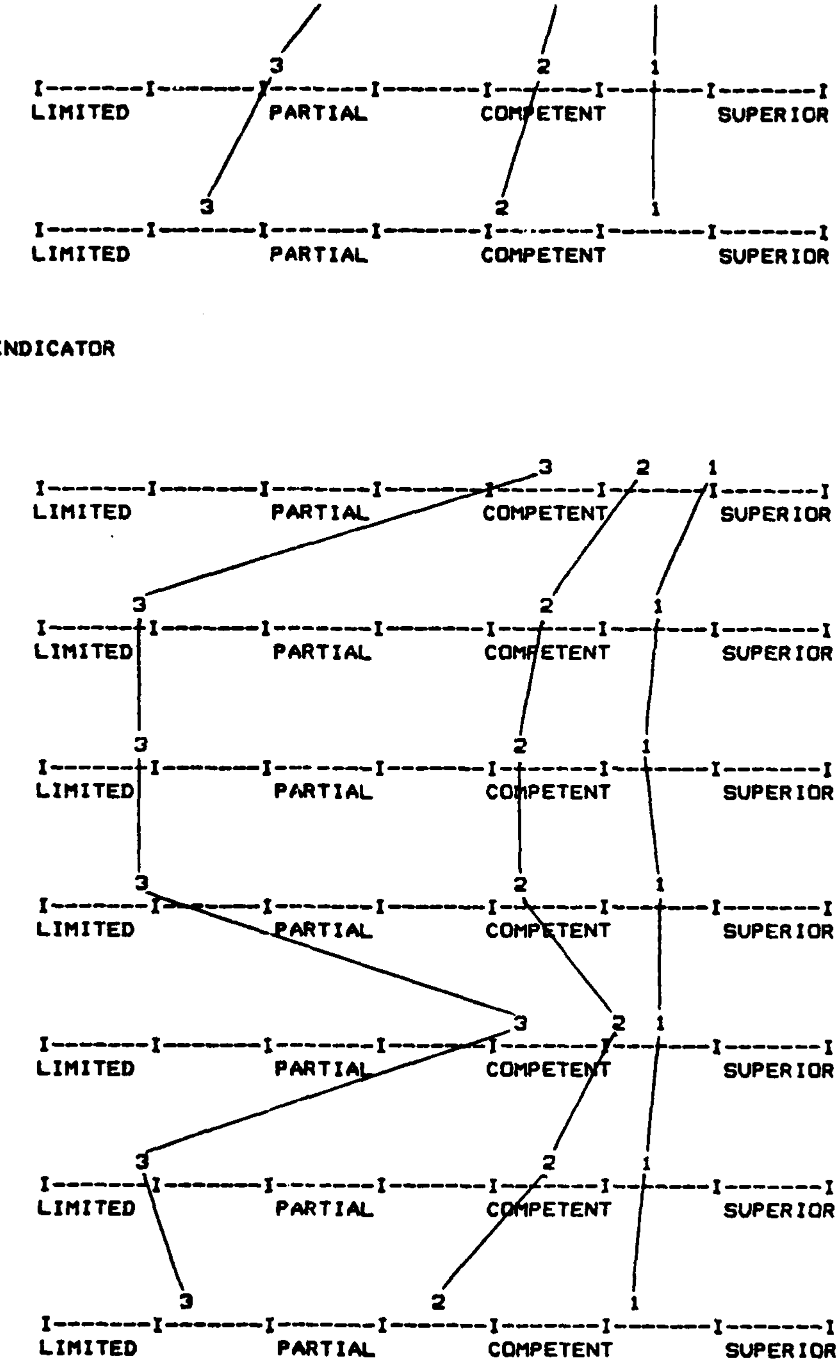
TIME CONSUMING: 0%
SQS-35 SQS-26
SQS-23



REMOVE/REPLACE CONSOLE 2 COMPONENTS SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 10%	SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST CONSOLE 2	TIME CONSUMING: 33%	SQS-35 SQS-26 SQS-23

ST: CONSOLE 3/CONTROL INDICATOR

CLEAN CONSOLE 3	TIME CONSUMING: 16%	SQS-26
TEST/INSPECT CONSOLE 3	TIME CONSUMING: 0%	SQS-26
LOCALIZE/ISOLATE CONSOLE 3 MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 0%	SQS-26
LOCALIZE/ISOLATE CONSOLE 3 MALFUNCTION TO THE COMPONENT LEVEL SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 14%	SQS-26
REMOVE/REPLACE CONSOLE 3 MODULES/CARDS	TIME CONSUMING: 0%	SQS-26
REMOVE/REPLACE CONSOLE 3 COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 0%	SQS-26
CALIBRATE/ALIGN/ADJUST CONSOLE 3	TIME CONSUMING: 14%	SQS-26



ST. CONTROL CONVERTER

CLEAN CONTROL CONVERTER

```
*                                   3         2    1            *  TIME CONSUMING:  0%
I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TEST/INSPECT CONTROL CONVERTER

```
*     3                                2         1              *  TIME CONSUMING: 20%
I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

LOCALIZE/ISOLATE CONTROL CONVERTER
MALFUNCTION TO THE MODULE/CARD LEVEL

```
*     3                              2           1              *  TIME CONSUMING:  0%
I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

LOCALIZE/ISOLATE CONTROL CONVERTER
MALFUNCTION TO THE COMPONENT LEVEL, SUCH
AS SWITCHES, RESISTORS, CAPACITORS,
TRANSISTORS, ICS, ETC.

```
*          3                           2         1              *  TIME CONSUMING:  0%
I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

REMOVE/REPLACE CONTROL CONVERTER
MODULES/CARDS

```
*                           3            2       1              *  TIME CONSUMING:  0%
I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

REMOVE/REPLACE CONTROL CONVERTER
COMPONENTS, SUCH AS SWITCHES, RESISTORS,
CAPACITORS, TRANSISTORS, ICS, ETC.

```
*                 3                    2         1              *  TIME CONSUMING: 20%
I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

CALIBRATE/ALIGN/ADJUST CONTROL
CONVERTER

```
*     3                                2         1              *  TIME CONSUMING: 20%
I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

ST: CONVERTER A-SCAN

CLEAN CONVERTER A-SCAN

```
                                     3        2    1              TIME CONSUMING:  0%
I-------I-------I-------I-------I-------I-------I-------I   SQS-26
LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

TEST/INSPECT CONVERTER A-SCAN

TIME CONSUMING: 28%
SQS-26

LOCALIZE/ISOLATE CONVERTER A-SCAN MALFUNCTION TO THE MODULE/CARD LEVEL

TIME CONSUMING: 14%
SQS-26

LOCALIZE/ISOLATE CONVERTER A-SCAN MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

TIME CONSUMING: 0%
SQS-26

REMOVE/REPLACE CONVERTER A-SCAN MODULES/CARDS

TIME CONSUMING: 0%
SQS-26

REMOVE/REPLACE CONVERTER A-SCAN COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

TIME CONSUMING: 0%
SQS-26

CALIBRATE/ALIGN/ADJUST CONVERTER A-SCAN

TIME CONSUMING: 42%
SQS-26

ST: CONVERTER B-SCAN

CLEAN CONVERTER B-SCAN

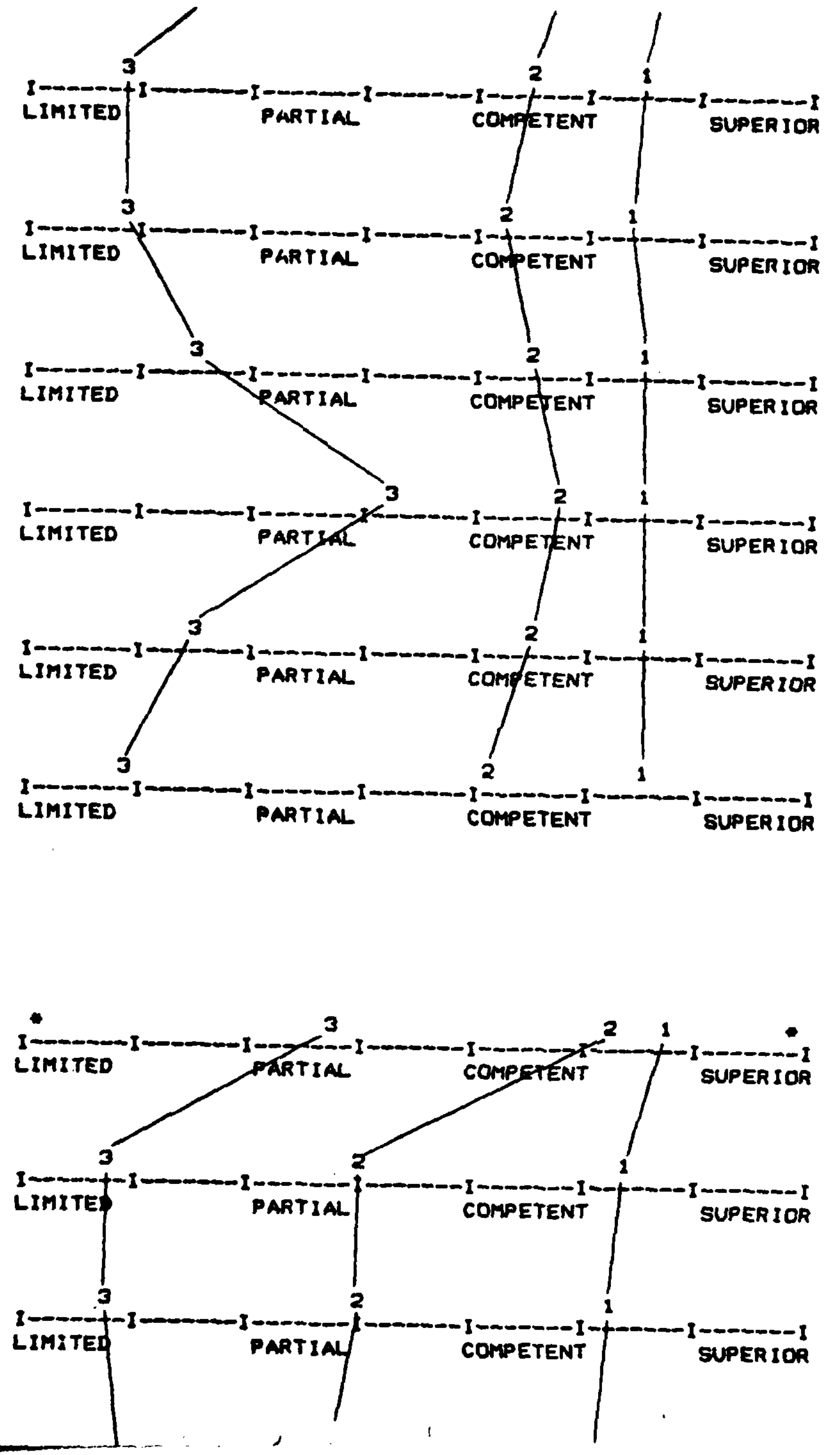
TIME CONSUMING: 0%
SQS-26

TEST/INSPECT CONVERTER B-SCAN

TIME CONSUMING: 16%
SQS-26

LOCALIZE/ISOLATE CONVERTER B-SCAN MALFUNCTION TO THE MODULE/CARD LEVEL

TIME CONSUMING: 0%
SQS-26



LOCALIZE/ISOLATE CONVERTER B-SCAN MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 16% SQS-26
REMOVE/REPLACE CONVERTER B-SCAN MODULES/CARDS	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 16% SQS-26
REMOVE/REPLACE CONVERTER B-SCAN COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 0% SQS-26
CALIBRATE/ALIGN/ADJUST CONVERTER B-SCAN	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 33% SQS-26

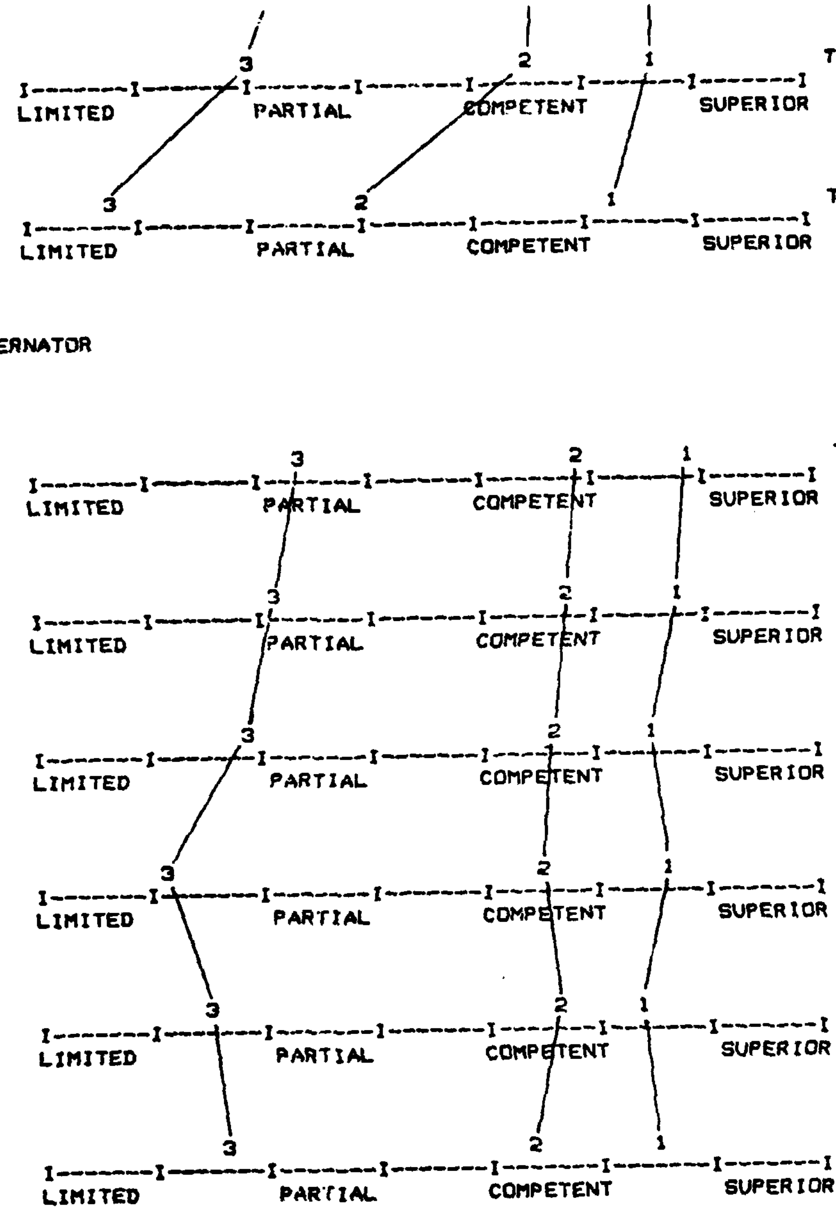
ST: MODULATOR-SCANNER

CLEAN SONAR MODULATOR-SCANNER	* LIMITED / PARTIAL / COMPETENT / SUPERIOR *	TIME CONSUMING: 0% SQS-26 SQS-23
TEST/INSPECT SONAR MODULATOR-SCANNER	* LIMITED / PARTIAL / COMPETENT / SUPERIOR *	TIME CONSUMING: 0% SQS-26 SQS-23
LOCALIZE/ISOLATE SONAR MODULATOR-SCANNER MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 0% SQS-26 SQS-23
LOCALIZE/ISOLATE SONAR MODULATOR-SCANNER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 0% SQS-26 SQS-23
REMOVE/REPLACE SONAR MODULATOR-SCANNER MODULES/CARDS	LIMITED / PARTIAL / COMPETENT / SUPERIOR	TIME CONSUMING: 0% SQS-26 SQS-23

Task	Time consuming
REMOVE/REPLACE SONAR MODULATOR-SCANNER COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 16% SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST SONAR MODULATOR-SCANNER	TIME CONSUMING: 16% SQS-26 SQS-23

ST: MOTOR GENERATOR/ALTERNATOR

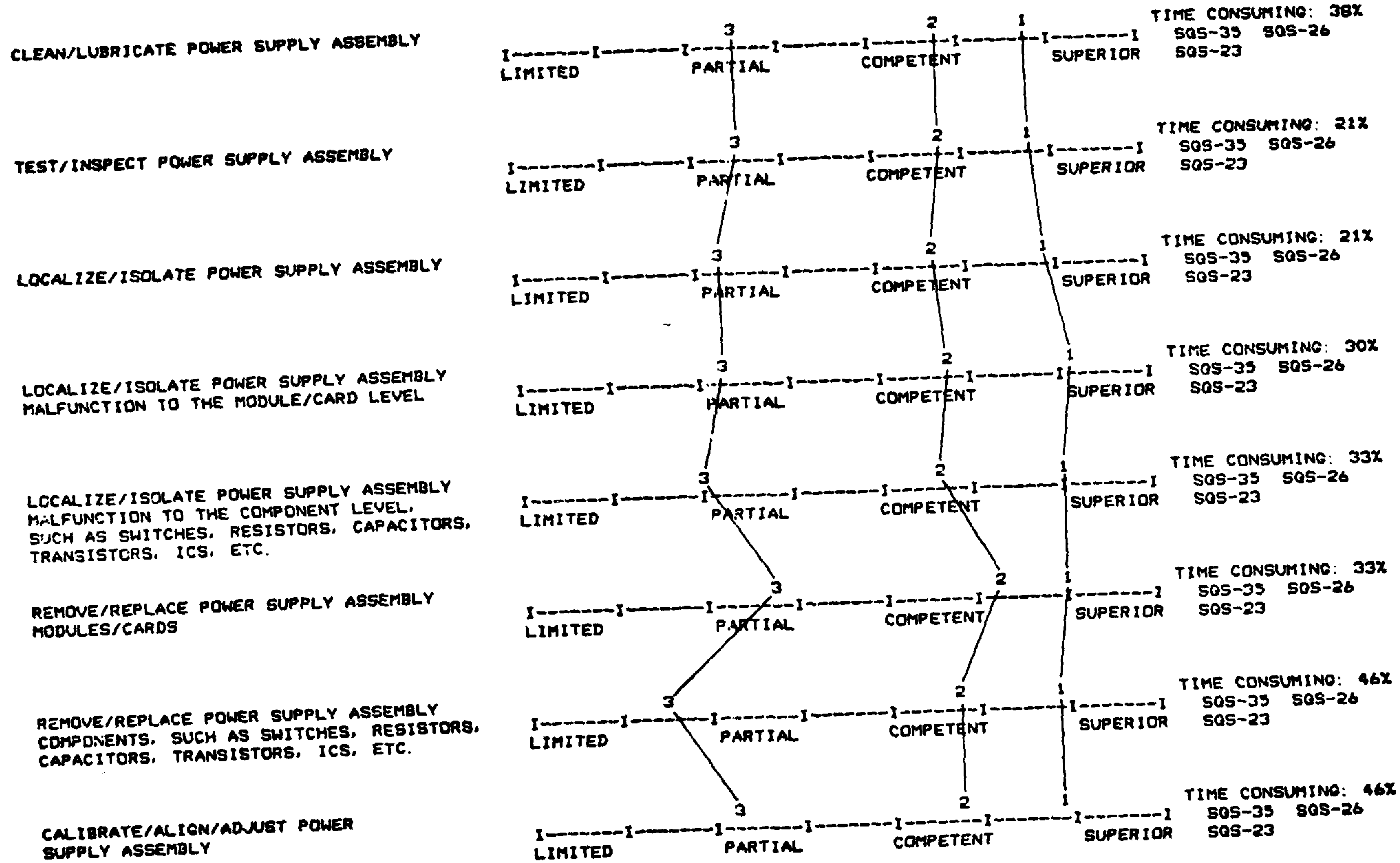
Task	Time consuming
CLEAN/LUBRICATE MOTOR GENERATOR/ ALTERNATOR	TIME CONSUMING: 40% SQS-35 SQS-26 SQS-23
TEST/INSPECT MOTC-' GENERATOR/ ALTERNATOR	TIME CONSUMING: 13% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE MOTOR GENERATOR/ ALTERNATOR MALFUNCTION TO A UNIT	TIME CONSUMING: 13% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE MOTOR GENERATOR/ ALTERNATOR MALFUNCTION TO THE COMPONENT LEVEL	TIME CONSUMING: 38% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE MOTOR GENERATOR/ ALTERNATOR COMPONENTS	TIME CONSUMING: 40% SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST MOTOR GENERATOR/ALTERNATOR	TIME CONSUMING: 53% SQS-35 SQS-26 SQS-23



ST: PHASE CHANGING NETWORK

```
CLEAN PHASE CHANGING NETWORK                              3                         2 1        TIME CONSUMING:  0%
                                     I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
                                     LIMITED         PARTIAL         COMPETENT       SUPERIOR

TEST/INSPECT PHASE CHANGING NETWORK          3                            2       1            TIME CONSUMING: 33%
                                     I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
                                     LIMITED         PARTIAL         COMPETENT       SUPERIOR

TEST/INSPECT PHASE CHANGING NETWORK          3                           2        1            TIME CONSUMING: 50%
                                     I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
                                     LIMITED         PARTIAL         COMPETENT       SUPERIOR

LOCALIZE/ISOLATE PHASE CHANGING NETWORK    *    3                      2         1          *  TIME CONSUMING: 20%
MALFUNCTION TO THE MODULE/CARD LEVEL I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
                                     LIMITED         PARTIAL         COMPETENT       SUPERIOR

LOCALIZE/ISOLATE PHASE CHANGING NETWORK      3                            2        1           TIME CONSUMING: 16%
MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
SWITCHES, RESISTORS, CAPACITORS,     LIMITED         PARTIAL         COMPETENT       SUPERIOR
TRANSISTORS, ICS, ETC.

REMOVE/REPLACE PHASE CHANGING NETWORK      *    3                         2        1          *  TIME CONSUMING: 20%
MODULES/CARDS                        I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
                                     LIMITED         PARTIAL         COMPETENT       SUPERIOR

REMOVE/REPLACE PHASE CHANGING NETWORK        3                           2        1            TIME CONSUMING: 66%
COMPONENTS, SUCH AS SWITCHES, RESISTORS, I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
CAPACITORS, TRANSISTORS, ICS, ETC.   LIMITED         PARTIAL         COMPETENT       SUPERIOR

CALIBRATE/ALIGN/ADJUST PHASE                3                            2        1            TIME CONSUMING: 33%
CHANGING NETWORK                     I-------I-------I-------I-------I-------I-------I-------I   SQS-26  SQS-23
                                     LIMITED         PARTIAL         COMPETENT       SUPERIOR
```

ST: POWER SUPPLY ASSEMBLY

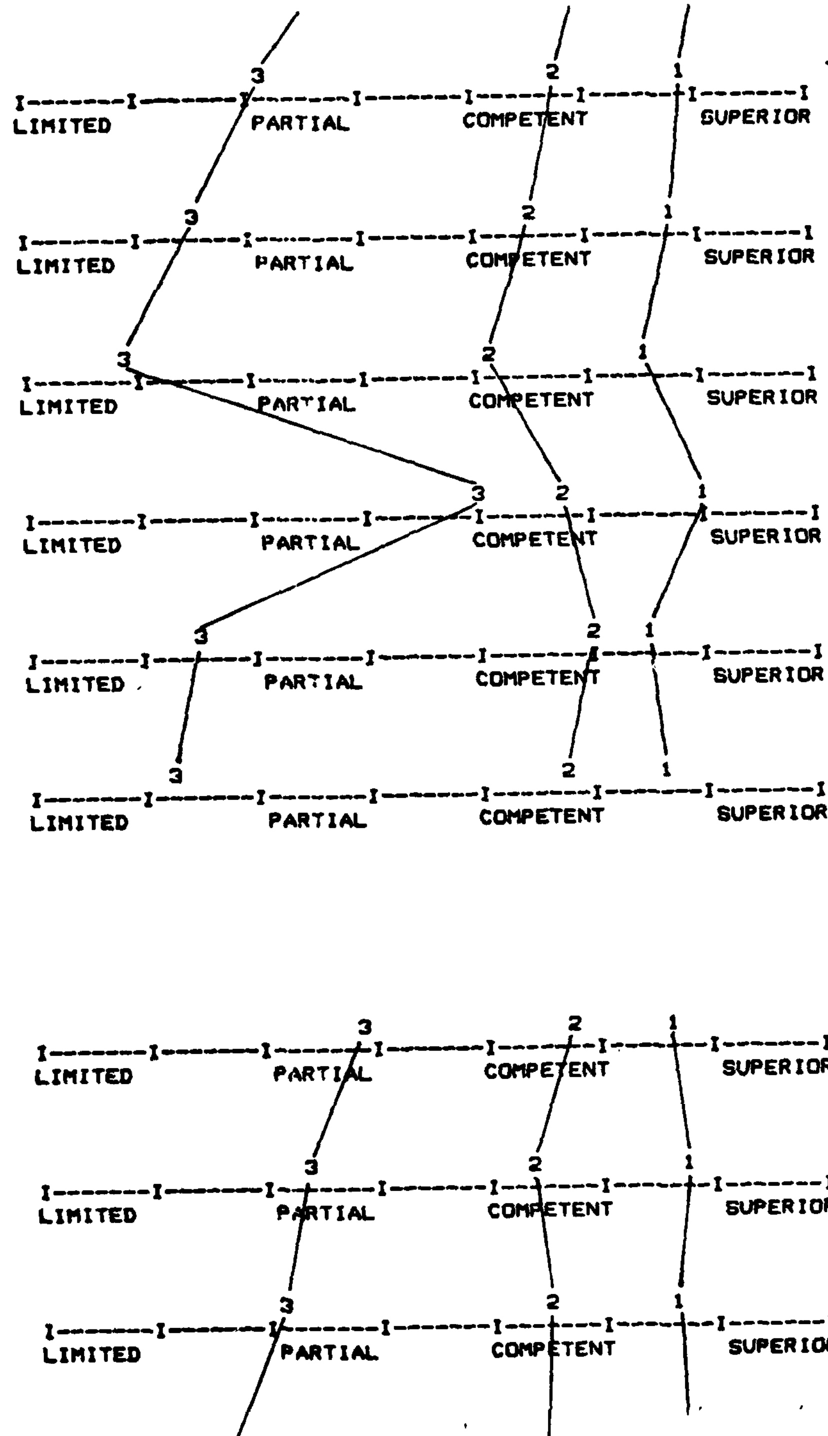


ST: PRE-AMP AND BEAMFORMER

CLEAN PREAMP AND BEAMFORMER	3 2 1 I--------I--------I--------I--------I--------I--------I--------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 23% SQS-35 SQS-26 SQS-23
TEST/INSPECT PREAMP AND BEAMFORMER	3 2 1 I--------I--------I--------I--------I--------I--------I--------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 25% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE PREAMP AND BEAMFORMER MALFUNCTION TO THE MODULE/CARD LEVEL	3 2 1 I--------I--------I--------I--------I--------I--------I--------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 23% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE PREAMP AND BEAMFORMER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3 2 1 I--------I--------I--------I--------I--------I--------I--------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 23% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE PREAMP AND BEAMFORMER MODULES/CARDS	3 2 1 I--------I--------I--------I--------I--------I--------I--------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 15% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE PREAMP AND BEAMFORMER COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3 2 1 I--------I--------I--------I--------I--------I--------I--------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 29% SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST PREAMP AND BEAMFORMER	3 2 1 I--------I--------I--------I--------I--------I--------I--------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 29% SQS-35 SQS-26 SQS-23

ST: PULSE SWEEP GENERATOR

CLEAN PULSE SWEEP GENERATOR	3 2 1 I--------I--------I--------I--------I--------I--------I--------I LIMITED PARTIAL COMPETENT SUPERIOR	TIME CONSUMING: 12% SQS-35 SQS-26 SQS-23



Task	Time consuming
TEST/INSPECT PULSE SWEEP GENERATOR	TIME CONSUMING: 11% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE PULSE SWEEP GENERATOR MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 12% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE PULSE SWEEP GENERATOR MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 11% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE PULSE SWEEP GENERATOR MODULES/CARDS	TIME CONSUMING: 12% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE PULSE SWEEP GENERATOR COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 12% SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST PULSE SWEEP GENERATOR	TIME CONSUMING: 0% SQS-35 SQS-26 SQS-23

ST: RECEIVER-SCANNER

Task	Time consuming
CLEAN SONAR RECEIVER-SCANNER	TIME CONSUMING: 37% SQS-35 SQS-26 SQS-23
TEST/INSPECT SONAR RECEIVER-SCANNER	TIME CONSUMING: 22% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE SONAR RECEIVER-SCANNER MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 25% SQS-35 SQS-26 SQS-23

LOCALIZE/ISOLATE SONAR RECEIVER-SCANNER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 23% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE SONAR RECEIVER/SCANNER MODULES/CARDS	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 15% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE SONAR RECEIVER-SCANNER COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 29% SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST SONAR RECEIVER-SCANNER	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 44% SQS-35 SQS-26 SQS-23

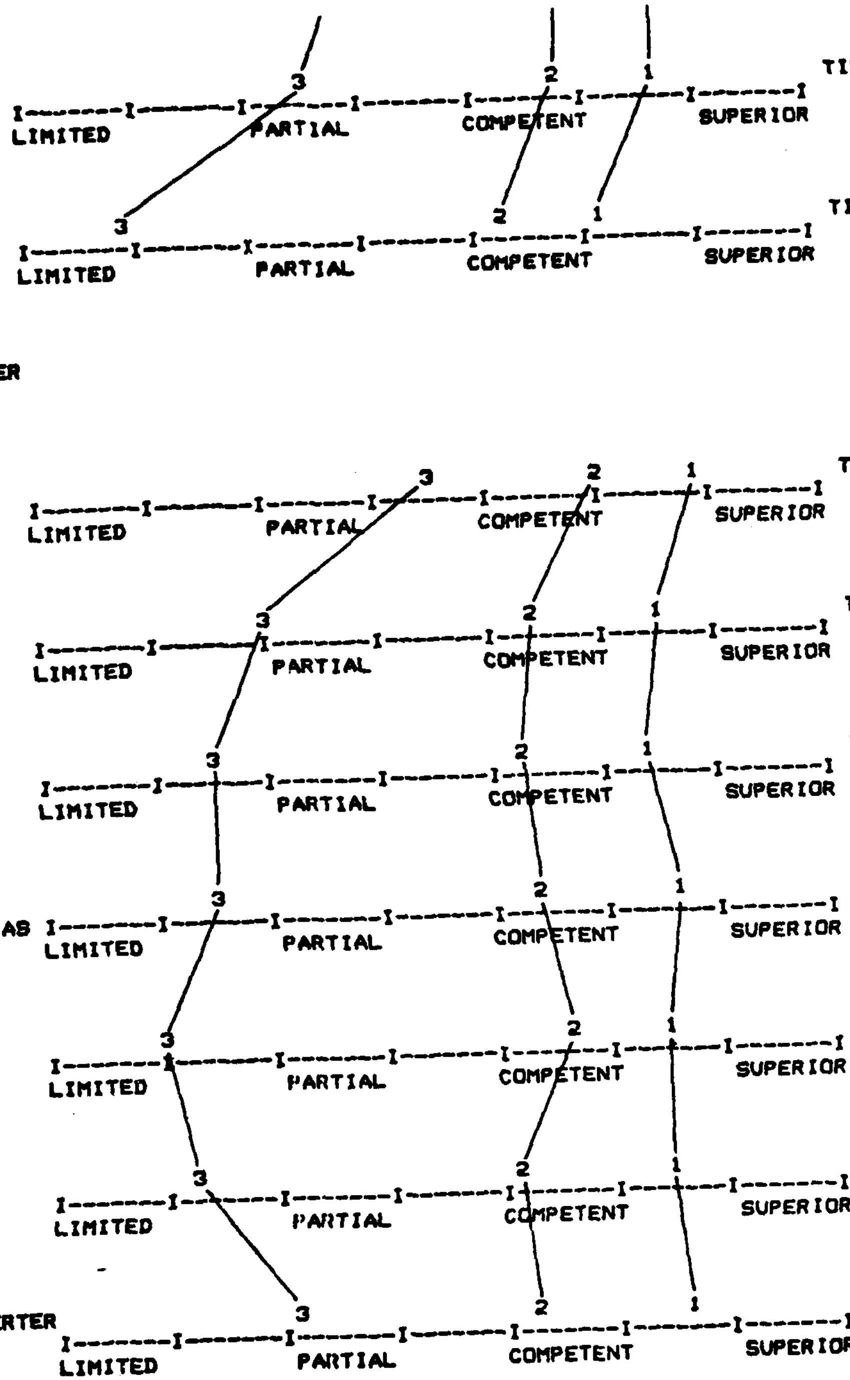
ST: SCAN SWITCH CONVERTER

CLEAN SCAN SWITCH CONVERTER	* LIMITED — PARTIAL — COMPETENT — SUPERIOR *	TIME CONSUMING: 20% SQS-26 SQS-23
TEST/INSPECT SCAN SWITCH CONVERTER	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 0% SQS-26 SQS-23
LOCALIZE/ISOLATE SCAN SWITCH CONVERTER MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 0% SQS-26 SQS-23
LOCALIZE/ISOLATE SCAN SWITCH CONVERTER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 0% SQS-26 SQS-23
REMOVE/REPLACE SCAN SWITCH CONVERTER MODULES/CARDS	LIMITED — PARTIAL — COMPETENT — SUPERIOR	TIME CONSUMING: 0% SQS-26 SQS-23

Task	Time consuming
REMOVE/REPLACE SCAN SWITCH CONVERTER COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 14% SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST SCAN SWITCH CONVERTER	TIME CONSUMING: 28% SQS-26 SQS-23

ST: SIGNAL DATA CONVERTER

Task	Time consuming
CLEAN SIGNAL DATA CONVERTER	TIME CONSUMING: 12% SQS-35 SQS-26 SQS-23
TEST/INSPECT SIGNAL DATA CONVERTER	TIME CONSUMING: 17% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE SIGNAL DATA CONVERTER MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 16% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE SIGNAL DATA CONVERTER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 25% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE SIGNAL DATA CONVERTER MODULES/CARDS	TIME CONSUMING: 41% SQS-26 SQS-23
REMOVE/REPLACE SIGNAL DATA CONVERTER COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 31% SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST SIGNAL DATA CONVERTER	TIME CONSUMING: 29% SQS-35 SQS-26 SQS-23



ST: SIGNAL PROCESSOR

CLEAN SONAR SIGNAL PROCESSOR — TIME CONSUMING: 11%
SQS-35 SQS-26
SQS-23

TEST/INSPECT SONAR SIGNAL PROCESSOR — TIME CONSUMING: 0%
SQS-35 SQS-26
SQS-23

LOCALIZE/ISOLATE SONAR SIGNAL PROCESSOR MALFUNCTION TO THE MODULE/CARD LEVEL — TIME CONSUMING: 0%
SQS-35 SQS-26
SQS-23

LOCALIZE/ISOLATE SONAR SIGNAL PROCESSOR MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — TIME CONSUMING: 0%
SQS-35 SQS-26
SQS-23

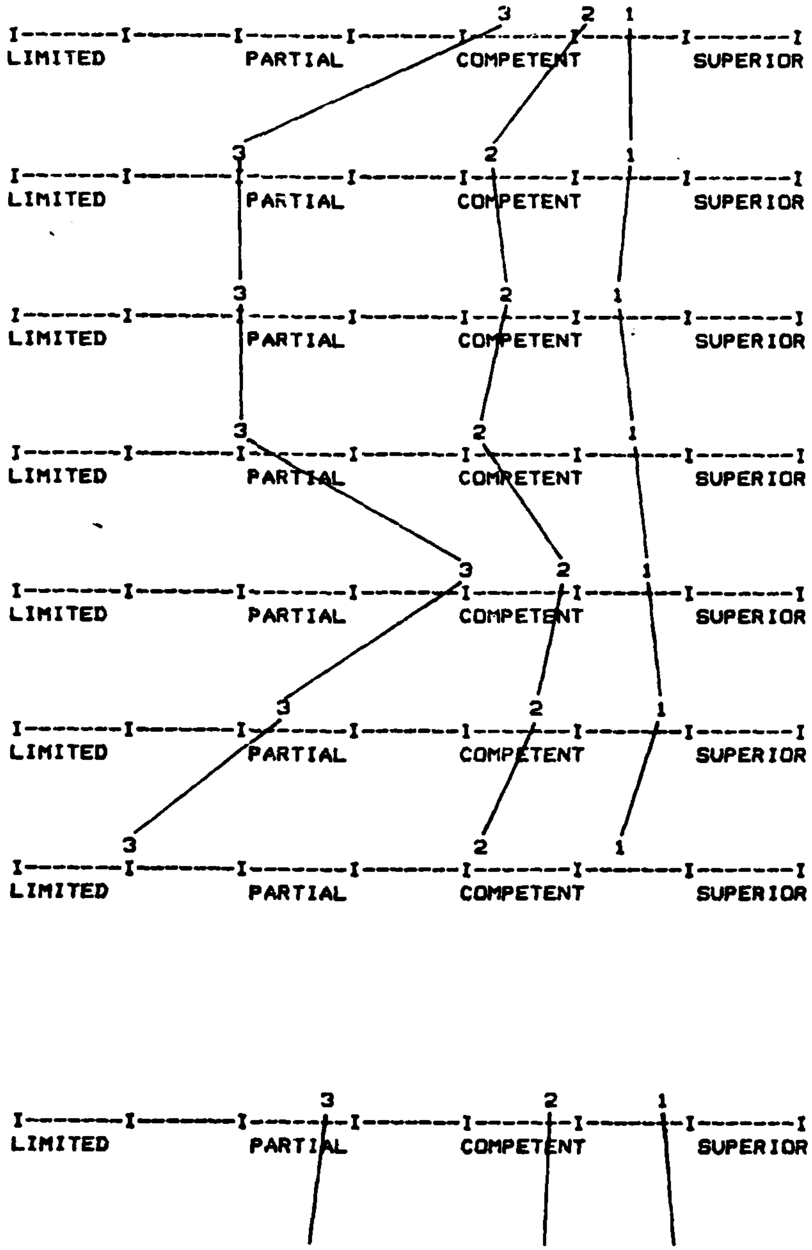
REMOVE/REPLACE SONAR SIGNAL PROCESSOR MODULES/CARDS — TIME CONSUMING: 0%
SQS-35 SQS-26
SQS-23

REMOVE/REPLACE SONAR SIGNAL PROCESSOR COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC. — TIME CONSUMING: 18%
SQS-35 SQS-26
SQS-23

CALIBRATE/ALIGN/ADJUST SONAR SIGNAL PROCESSOR — TIME CONSUMING: 18%
SQS-35 SQS-26
SQS-23

ST: TIMER SEQUENTIAL

CLEAN TIMER SEQUENTIAL — TIME CONSUMING: 14%
SQS-26 SQS-23

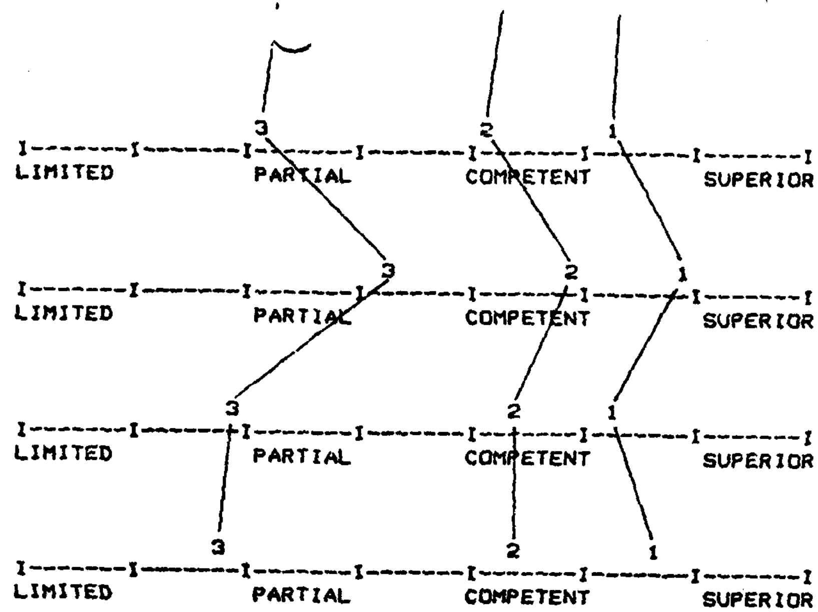


TEST/INSPECT TIMER SEQUENTIAL	LIMITED — PARTIAL (3) — COMPETENT (2) — SUPERIOR (1)	TIME CONSUMING: 12% SQS-26 SQS-23
LOCALIZE/ISOLATE TIMER SEQUENTIAL MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED — PARTIAL (3) — COMPETENT (2) — SUPERIOR (1)	TIME CONSUMING: 12% SQS-26 SQS-23
LOCALIZE/ISOLATE TIMER SEQUENTIAL MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED (3) — PARTIAL — COMPETENT (2) — SUPERIOR (1)	TIME CONSUMING: 12% SQS-26 SQS-23
REMOVE/REPLACE TIMER SEQUENTIAL MODULES/CARDS	LIMITED — PARTIAL (3) — COMPETENT (2) — SUPERIOR (1)	TIME CONSUMING: 12% SQS-26 SQS-23
REMOVE/REPLACE TIMER SEQUENTIAL COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	LIMITED — PARTIAL (3) — COMPETENT (2) — SUPERIOR (1)	TIME CONSUMING: 25% SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST TIMER SEQUENTIAL	LIMITED — PARTIAL (3) — COMPETENT (2) — SUPERIOR (1)	TIME CONSUMING: 37% SQS-26 SQS-23

ST: TRANSMITTER

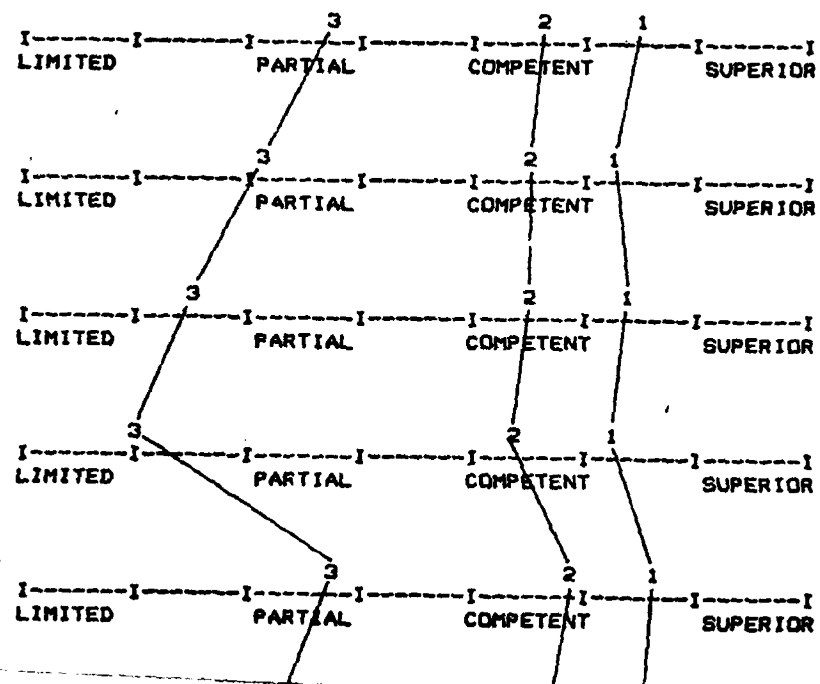
CLEAN SONAR TRANSMITTER	LIMITED — PARTIAL (3) — COMPETENT (2) — SUPERIOR (1)	TIME CONSUMING: 17% SQS-35 SQS-26 SQS-23
TEST/INSPECT SONAR TRANSMITTER	LIMITED — PARTIAL (3) — COMPETENT (2) — SUPERIOR (1)	TIME CONSUMING: 11% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE SONAR TRANSMITTER MALFUNCTION TO THE MODULE/CARD LEVEL	LIMITED — PARTIAL (3) — COMPETENT (2) — SUPERIOR (1)	TIME CONSUMING: 20% SQS-35 SQS-26 SQS-23

Task	Time consuming
LOCALIZE/ISOLATE SONAR TRANSMITTER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 22% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE SONAR TRANSMITTER MODULES/CARDS	TIME CONSUMING: 14% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE SONAR TRANSMITTER COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 22% SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST SONAR TRANSMITTER	TIME CONSUMING: 25% SQS-35 SQS-26 SQS-23



ST: TRANSMITTER CONTROL

Task	Time consuming
CLEAN TRANSMITTER CONTROL	TIME CONSUMING: 10% SQS-26 SQS-23
TEST/INSPECT TRANSMITTER CONTROL	TIME CONSUMING: 9% SQS-26 SQS-23
LOCALIZE/ISOLATE TRANSMITTER CONTROL MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 22% SQS-26 SQS-23
LOCALIZE/ISOLATE TRANSMITTER CONTROL MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 20% SQS-26 SQS-23
REMOVE/REPLACE TRANSMITTER CONTROL MODULES/CARDS	TIME CONSUMING: 22% SQS-26 SQS-23



REMOVE/REPLACE TRANSMITTER CONTROL COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

TIME CONSUMING: 27%
SGS-26 SGS-23

CALIBRATE/ALIGN/ADJUST TRANSMITTER CONTROL

TIME CONSUMING: 18%
SGS-26 SGS-23

ST: TRANSMITTER DRIVE CONTROL

CLEAN TRANSMITTER DRIVE CONTROL

TIME CONSUMING: 30%
SGS-26 SGS-23

TEST/INSPECT TRANSMITTER DRIVE CONTROL

TIME CONSUMING: 13%
SGS-26 SGS-23

LOCALIZE/ISOLATE TRANSMITTER DRIVE CONTROL MALFUNCTION TO THE MODULE/CARD LEVEL

TIME CONSUMING: 16%
SGS-26 SGS-23

LOCALIZE/ISOLATE TRANSMITTER DRIVE CONTROL MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

TIME CONSUMING: 16%
SGS-26 SGS-23

REMOVE/REPLACE TRANSMITTER DRIVE CONTROL MODULES/CARDS

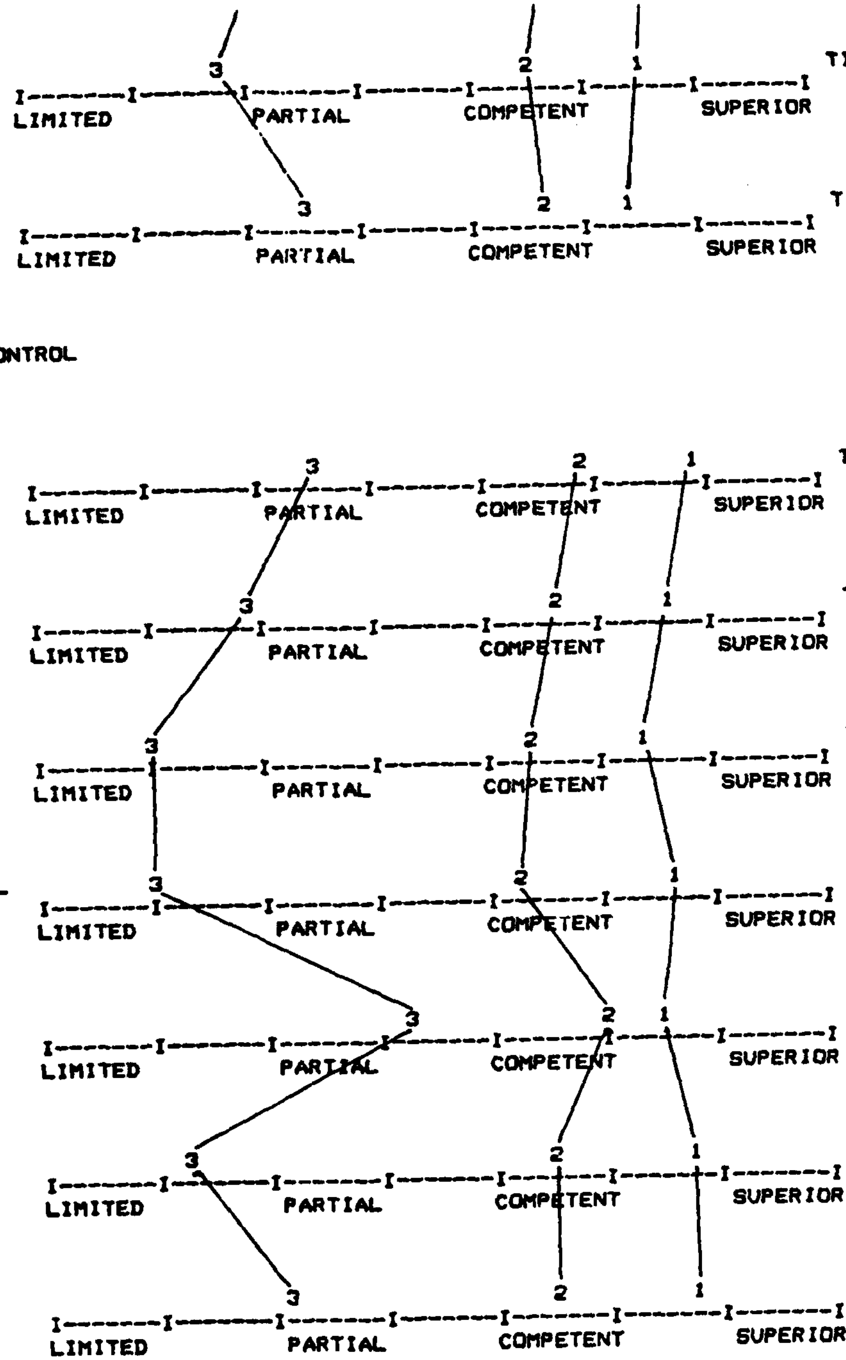
TIME CONSUMING: 0%
SGS-26 SGS-23

REMOVE/REPLACE TRANSMITTER DRIVE CONTROL COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.

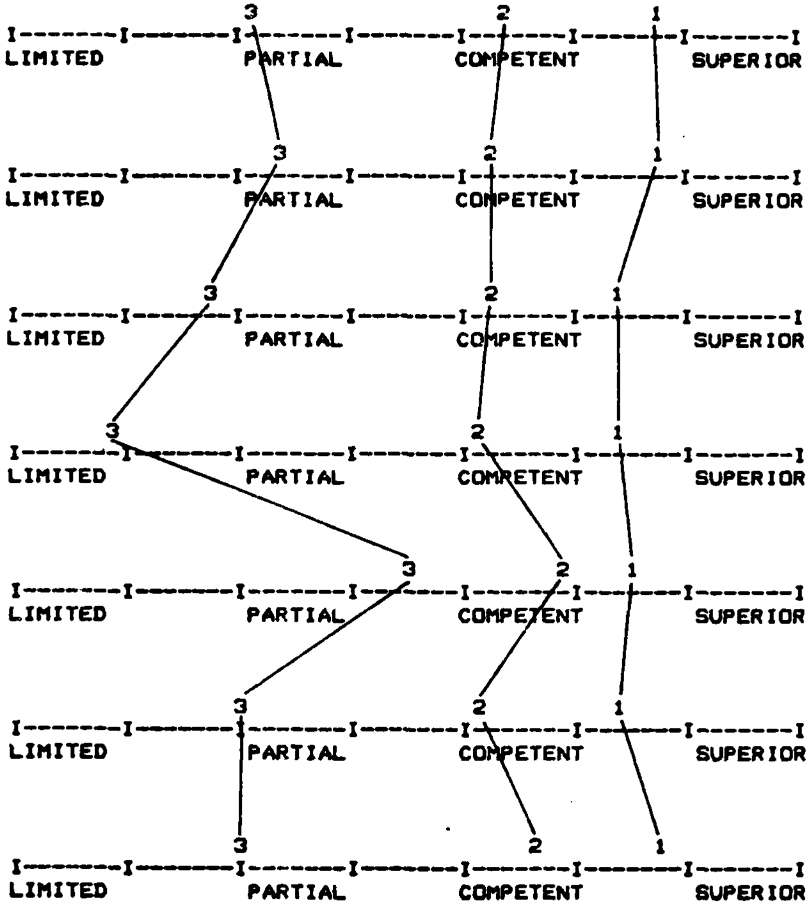
TIME CONSUMING: 30%
SGS-26 SGS-23

CALIBRATE/ALIGN/ADJUST TRANSMITTER DRIVE CONTROL

TIME CONSUMING: 30%
SGS-26 SGS-23



ST: TRANSMITTER-RECEIVER SWITCH



CLEAN TRANSMITTER-RECEIVER SWITCH	TIME CONSUMING: 40% SQS-35 SQS-26 SQS-23
TEST/INSPECT TRANSMITTER-RECEIVER SWITCH	TIME CONSUMING: 20% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE TRANSMITTER-RECEIVER SWITCH MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 27% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE TRANSMITTER-RECEIVER SWITCH MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 23% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE TRANSMITTER-RECEIVER SWITCH MODULES/CARDS	TIME CONSUMING: 18% SQS-35 SQS-26 SQS-23
REMOVE/REPLACE TRANSMITTER-RECEIVER SWITCH COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 28% SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST TRANSMITTER-RECEIVER SWITCH	TIME CONSUMING: 16% SQS-35 SQS-26 SQS-23

SECTION 7

DIFFICULT AND TIME-CONSUMING TASKS

ADDRESSING QUESTION 7

> What skill levels and number of operator and maintenance personnel are required to perform these tasks?

As shown in Figure 16, both Sections 6 and 7 of this guide need to be used in making estimates of the number and skill levels of required

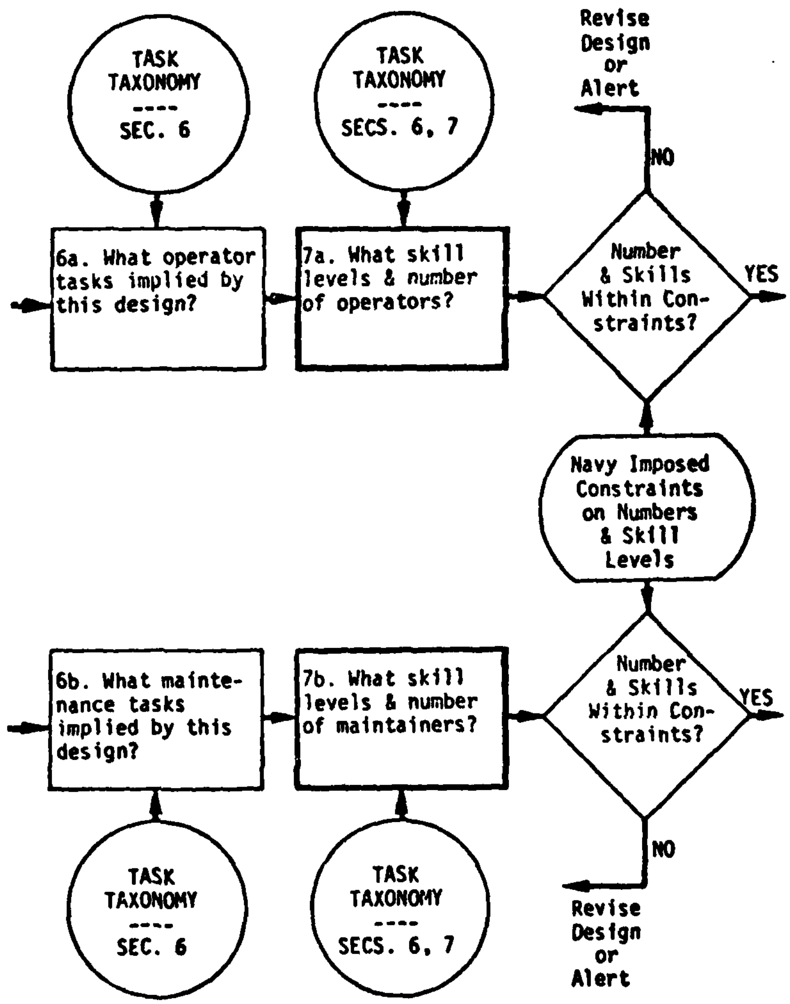


Figure 16. Addressing Question 7.

operator and maintainer personnel. However, the data in this guide can only partially answer Question 7. In addition to the task difficulty information provided here, information on the number of operator workstations to be manned for various watch conditions, operator task composition at each watch station, frequency and duration of maintenance tasks, and the difficulty level of new tasks (i.e., those not listed in Sections 6 and 7) must be employed. Most of this additional information will be specific to each new design, and can be estimated only by the system developer. The system developer can be aided in doing this, and in answering Question 7, by comparing the new design in detail to existing operational systems and their manning requirements. Unfortunately, total support of these steps is beyond the present scope of this guide.

However, regardless of the absolute numbers and skill levels required, it is clear that reducing the number of skill and manpower-intensive tasks should be a primary design objective. Even where the total effect of such reductions is not sufficient to decrease the required number or level of personnel, the effect will be to decrease task loading per man, thus benefiting operators and/or maintenance. The matter of difficult and time-consuming tasks <u>can</u> be addressed using data in this section. It provides selected data from the taxonomies presented in Section 6, on tasks that historically have proved most difficult and time consuming for Navy technical personnel to perform.

THE FOCUS IS ON DIFFICULT TASKS

> The most difficult tasks performed by each rating are skill-intensive and should be considered primary candidates for redesign or elimination.

To the extent that the designer can eliminate or simplify the more difficult operator and maintainer tasks, he should obviously do so in the interest of greater utilization of less skilled personnel and reduced training costs. To make it convenient to identify these tasks, a listing

of the 36 tasks considered most difficult for each rating to perform is presented on the following pages.

In many cases it will be seen that even second enlistment personnel (2nd class petty officers) are less than fully proficient at these tasks. For example, for DS personnel (see page 7-9) maintenance tasks associated with malfunctions in the chilled water system are likely to be competently performed only by 1st class (or higher) petty officer personnel. Therefore, anything the designer can do to simplify or eliminate these types of tasks in the new system would have a beneficial impact on required skill level and training.

TIME-CONSUMING TASKS ARE ALSO OF CONCERN

> The most time-consuming tasks are manpower-intensive and should also be considered primary candidates for redesign or elimination.

Following the difficult-task listing, a second group of tasks is listed that are considered to be particularly time consuming. There were substantial differences among the ratings in the number of tasks considered time consuming, and those differences are reflected in the different lengths of this second list.

A time-consuming task need not be particularly difficult to perform although it may be. For example, the task of calibrating and aligning display consoles is one of the most time-consuming tasks for DS personnel (page 7-13) but even 3rd class petty officers are considered "partially" proficient at this task.

In any case, whatever the designer can do to eliminate or simplify the most time-consuming tasks will be of obvious benefit in terms of manpower requirements.

USING THE DIFFICULT- AND TIME-CONSUMING-TASK DATA

> How are the data on difficult and time-consuming tasks to be used in the design process?

There are two potential uses of these two listings of tasks. One is to focus the designer's attention on tasks that are particularly demanding of high skill levels and man-hours as primary candidates for simplification or elimination. The second is to provide a means for comparative analysis of two or more designs under consideration with respect to the number of difficult and time-consuming tasks generated by each.

COMPARATIVE ANALYSIS

> How can a comparative analysis be done?

One simple approach to a comparative analysis is to complete a table of the type presented on page 7-5 (Table 3). This table is designed for any analysis of difficult tasks. Using the data in this section, the analyst first lists all tasks pertaining to <u>any</u> of his design options that appear in the list of difficult tasks. He then reviews each design alternative to determine if each of these tasks:

- Exists essentially unchanged from previous systems of this type.
- Exists, but has been made easier to perform.
- Has been eliminated (i.e., no longer requires human action).

Each task falling in the first category is assigned a weight of -1 and this value is entered into the table in the appropriate cell; similarly, each task in the second category is assigned +1; and each in the third category is assigned +3. (These values are admittedly arbitrary; other weighting schemes may be devised if desired.)

TABLE 3
DIFFICULT TASK ANALYSIS

TASK DESCRIPTION	SYSTEM A			SYSTEM B		
	UNCH* -1	EZ* +1	ELIM* +3	UNCH* -1	EZ* +1	ELIM* +3
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
.						
.						
.						
.						
.						
34.						
35.						
36.						
$\sum$	a	b	c	a	b	c

Difficult Task Index [Σ(a+b+c)] = ☐ ☐

*UNCH - Task essentially unchanged from taxonomy or other baseline equipment.
EZ - Task made easier to perform; simplified.
ELIM - Task no longer requires human involvement.

COMPUTING A DIFFICULT TASK INDEX

The result of this analysis is a "Difficult Task" index which serves as a basis for comparing all designs under consideration.

The algebraic sum of each column of Table 3 is next computed and entered into the boxes labeled a, b, and c. These sums are in turn summed into a "Difficult Task" index for each system. That system with the most positive score is preferred.

If the scores are substantially different, the design with the highest score is clearly less dependent on scarce, highly experienced personnel. Even if senior personnel remain essential for certain tasks, designs receiving a comparatively high score will make possible more complete use of lower level personnel for performing many operator and maintainer functions.

COMPUTING A TIME-CONSUMING INDEX

A "Time-Consuming" index can be developed using a similar procedure.

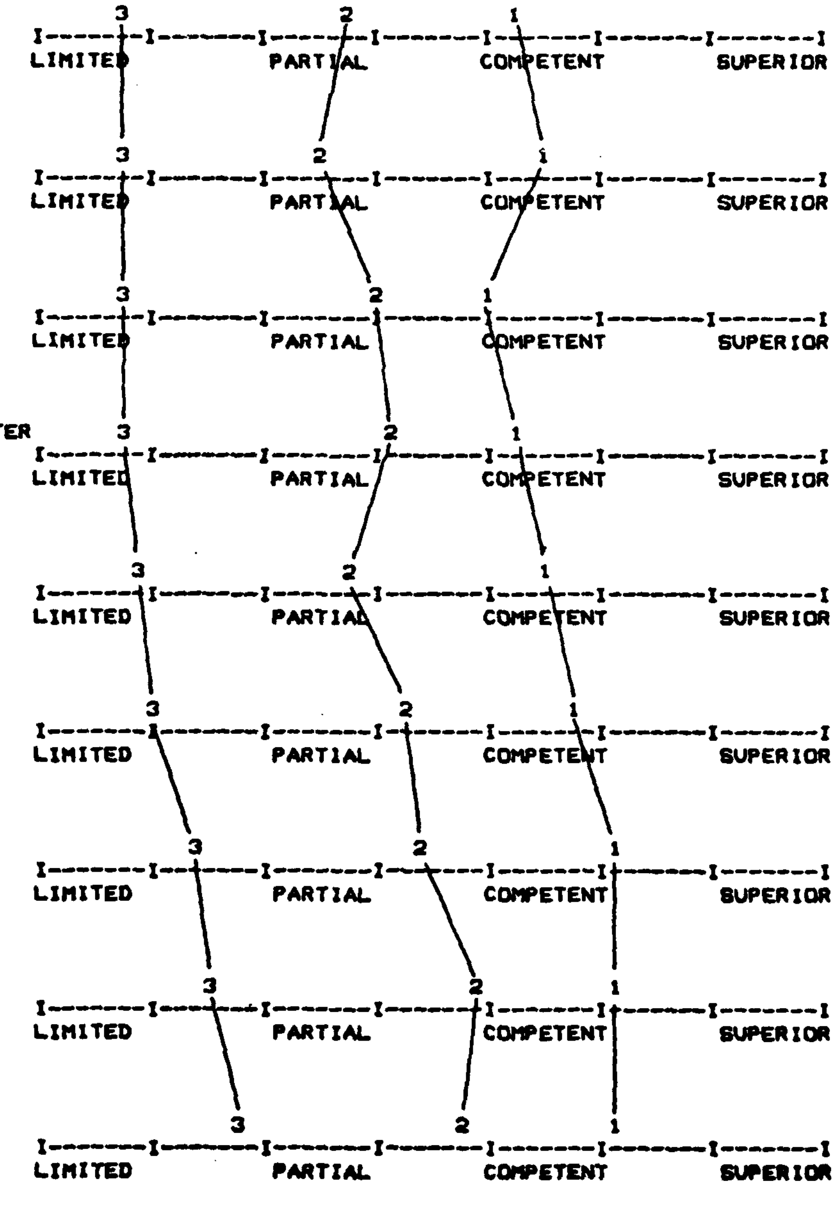
The model provided in Table 3 can also be used to perform a comparative analysis of two or more system designs with respect to the list of time-consuming tasks. Essentially, the procedure is the same as that described for the difficult-task list. If the analyst has actual data available on the time required for performing these tasks, he might find it desirable to weight each task by a factor based on those times prior to summing the scores for each design alternative.

DIFFICULT AND TIME-CONSUMING TASKS

DS

DIFFICULT DS TASKS

Task	Time consuming	Systems
LOCALIZE/ISOLATE COOLING CHILLED WATER SYSTEM MALFUNCTION TO THE PART LEVEL	11%	UYA-4, LHA, NTDS-3, NTDS-CV, USQ-20
DEBUG PROGRAMS (MAINTENANCE, OPERATIONAL)	48%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
REMOVE/REPLACE COOLING CHILLED WATER SYSTEM PARTS	42%	UYA-4, LHA, NTDS-3, NTDS-CV, USQ-20
CALIBRATE/ALIGN/ADJUST COOLING CHILLED WATER SYSTEM	7%	UYA-4, LHA, NTDS-3, NTDS-CV, USQ-20
WRITE/REWRITE PROGRAMS (MAINTENANCE, OPERATIONAL)	50%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
LOCALIZE/ISOLATE COOLING CHILLED WATER SYSTEM MALFUNCTION TO A UNIT	5%	UYA-4, LHA, NTDS-3, NTDS-CV, USQ-20
TEST NEW PROGRAMS (MAINTENANCE, OPERATIONAL)	33%	UYK-5, UYA-4, UYK-20, UYK-7, LHA, NTDS-3, NTDS-CV, USQ-20
CALIBRATE/ALIGN/ADJUST TELETYPE	29%	UYK-5, UYA-4, LHA, NTDS-3, NTDS-CV, USQ-20
LOCALIZE/ISOLATE DISK FILE MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	11%	UYK-5, UYK-20, LHA, NTDS-CV, USQ-20



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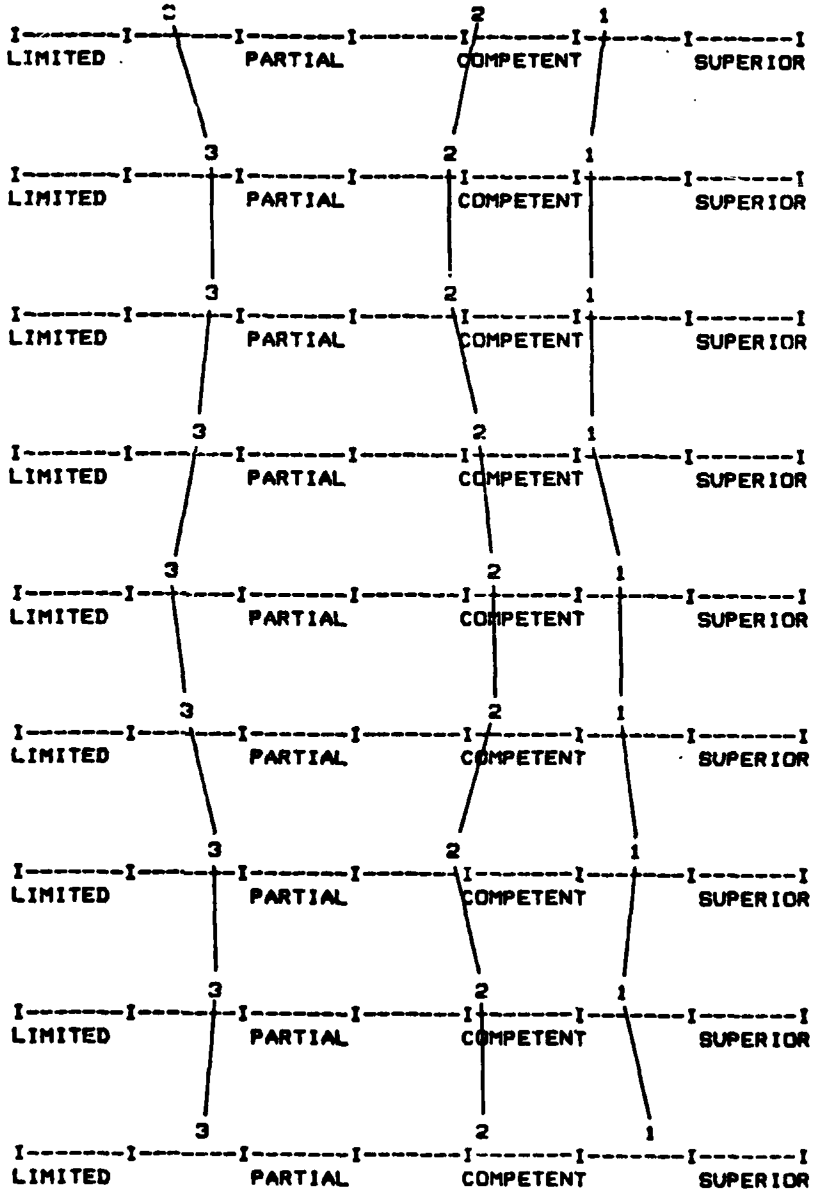
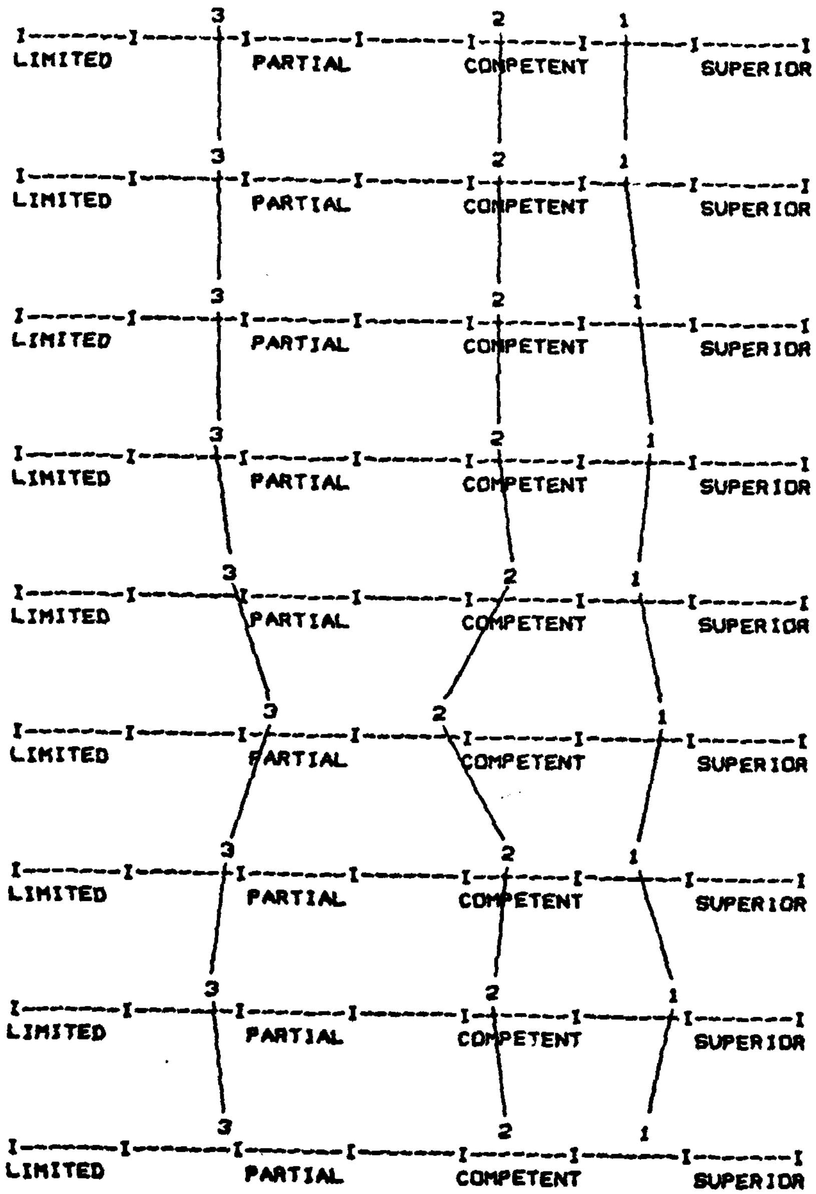
DIFFICULT DS TASKS



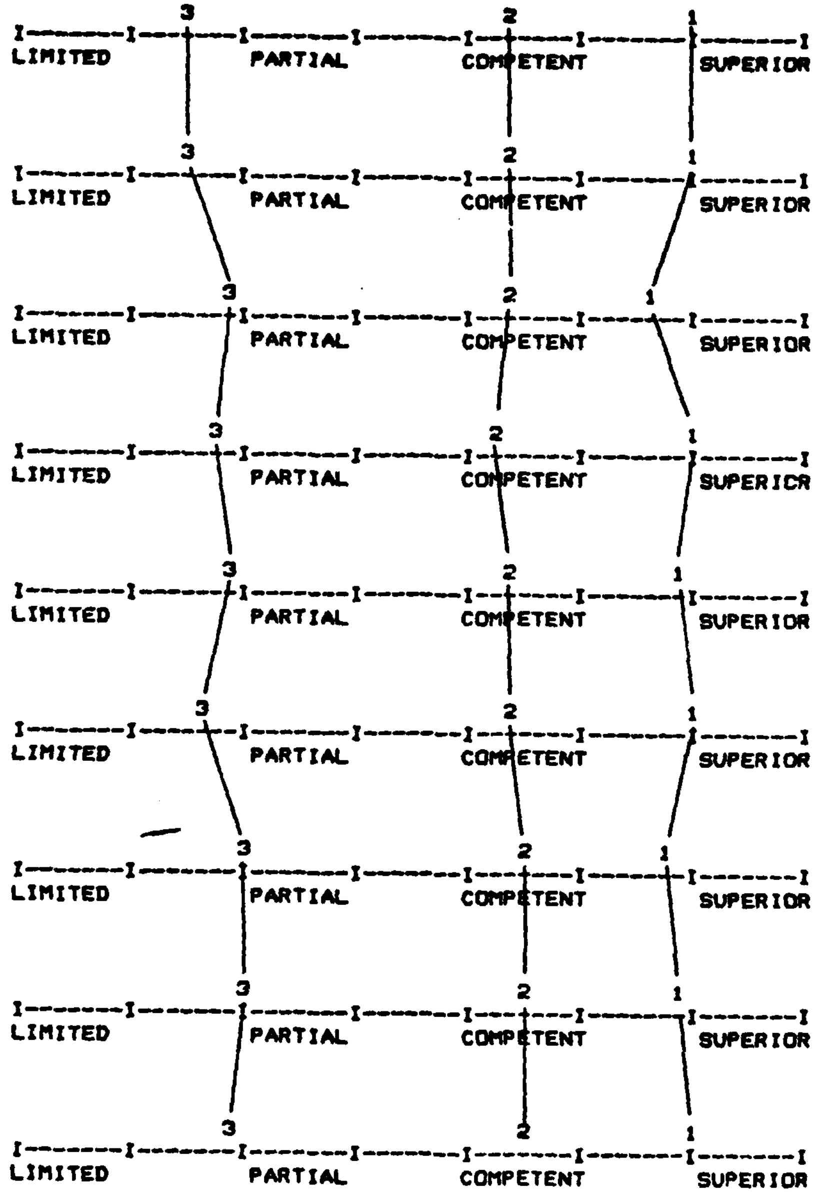
Task	Time Consuming	Systems
CALIBRATE/ALIGN/ADJUST A TO D AND D TO A CONVERTERS	31%	UYA-4 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
LOCALIZE/ISOLATE DISK FILE MALFUNCTION TO THE MODULE/CARD LEVEL	11%	UYK-5 UYK-20 LHA NTDS-CV USQ-20
TEST/INSPECT COOLING CHILLED WATER SYSTEM	21%	UYA-4 LHA NTDS-3 NTDS-CV USQ-20
CALIBRATE/ALIGN/ADJUST DISK FILE	33%	UYK-5 UYK-20 LHA NTDS-CV USQ-20
CALIBRATE/ALIGN/ADJUST CARD PUNCH	42%	UYK-5 UYK-20 LHA NTDS-CV USQ-20
LOCALIZE/ISOLATE A TO D AND D TO A CONVERTERS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	15%	UYA-4 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
CLEAN COOLING CHILLED WATER SYSTEM	40%	UYA-4 LHA NTDS-3 NTDS-CV USQ-20
MAKE AUTHORIZED CHANGES TO PROGRAMS	11%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
ALIGN/ADJUST MECHANICAL LINKAGES AND GEAR TRAINS	31%	UYK-5 UYA-4 UYK-20 LHA NTDS-3 NTDS-CV USQ-20

DIFFICULT DS TASKS

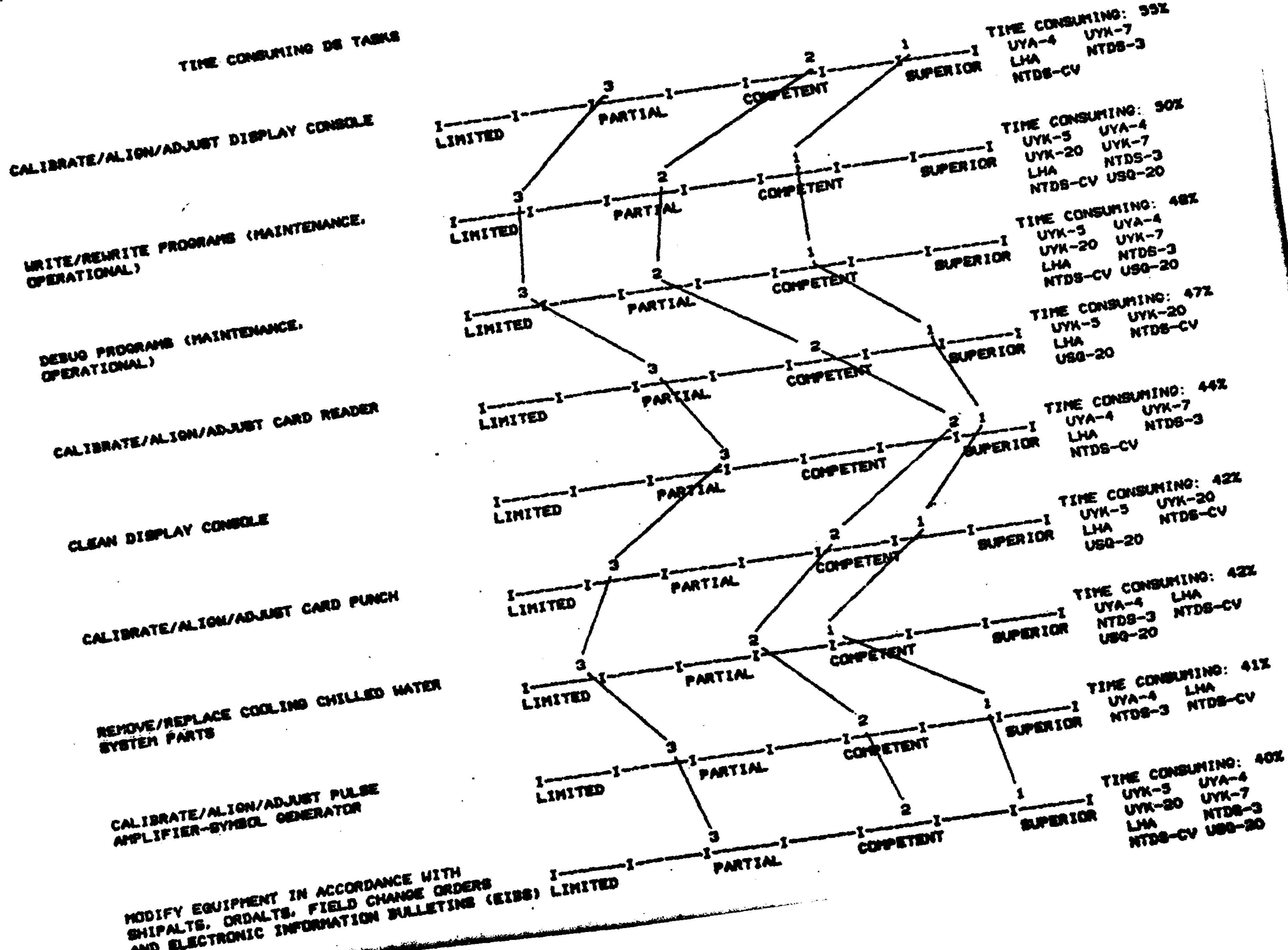


Task	Time consuming / Systems
REMOVE/REPLACE DISK FILE COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 11% UYK-5 UYK-20 LHA NTDS-CV USQ-20
REMOVE/REPLACE PAPER TAPE PUNCH COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 19% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
REMOVE/REPLACE A TO D AND D TO A CONVERTERS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 15% UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
LOCALIZE/ISOLATE CARD READER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 23% UYK-5 UYK-20 LHA NTDS-CV USQ-20
CLEAN/LUBRICATE DISK FILE	TIME CONSUMING: 11% UYK-5 UYK-20 LHA NTDS-CV USQ-20
INITIATE COMMUNICATIONS LINKS SUCH AS LINK 11, LINK 4A, LINK 14	TIME CONSUMING: 0% UYA-4 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
TEST/INSPECT DISK FILE	TIME CONSUMING: 11% UYK-5 UYK-20 LHA NTDS-CV USQ-20
CALIBRATE/ALIGN/ADJUST PULSE AMPLIFIER-SYMBOL GENERATOR	TIME CONSUMING: 41% UYA-4 LHA NTDS-3 NTDS-CV
LOCALIZE/ISOLATE DATA TERMINAL SET MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 0% UYA-4 UYK-7 LHA NTDS-3 NTDS-CV

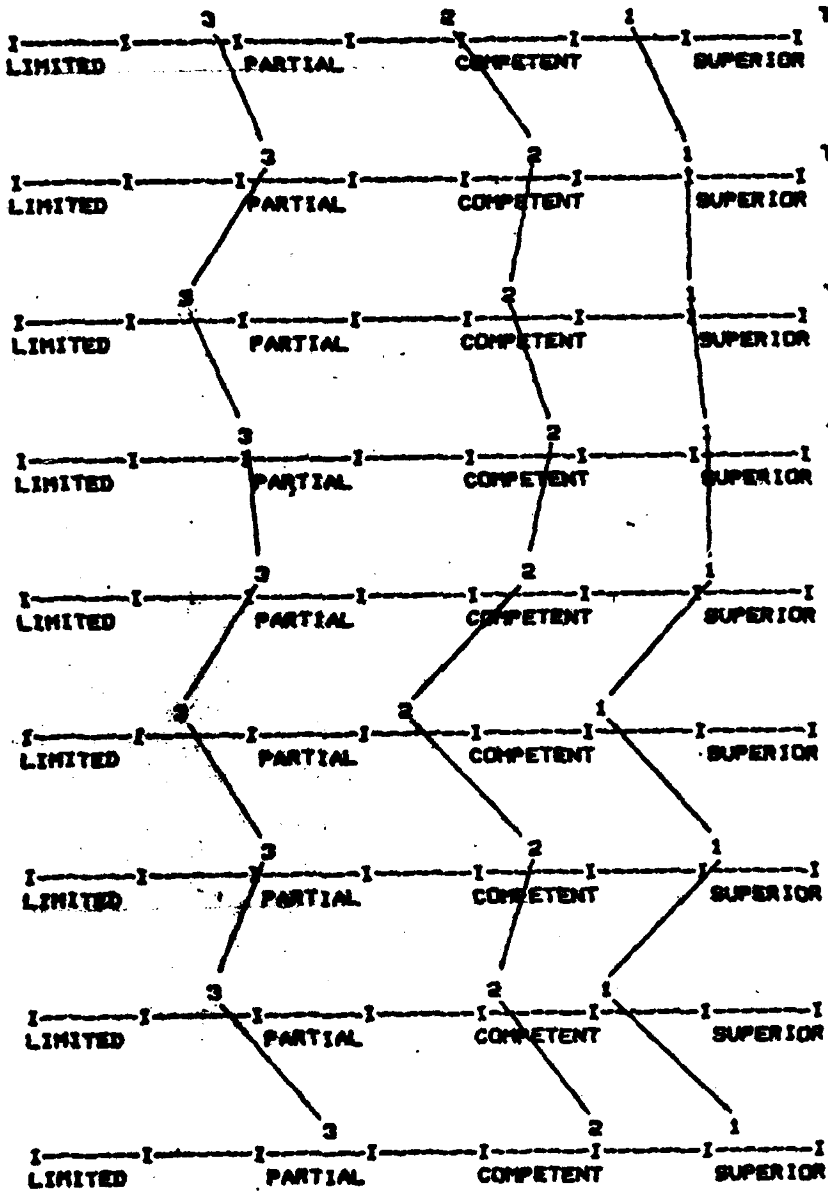
DIFFICULT DS TASKS



Task	Time consuming	Systems
CALIBRATE/ALIGN/ADJUST DATA TERMINAL SET	TIME CONSUMING: 35%	UYA-4 UYK-7 LHA NTDS-3 NTDS-CV
REMOVE/REPLACE V'DEO SIMULATOR COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 21%	UYA-4 LHA NTDS-3 NTDS-CV
CALIBRATE/ALIGN/ADJUST PAPER TAPE READER	TIME CONSUMING: 16%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
CALIBRATE/ALIGN/ADJUST PAPER TAPE PUNCH	TIME CONSUMING: 30%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
LOCALIZE/ISOLATE DIGITAL COMPUTER ELECTRONICS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 27%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
LOCALIZE/ISOLATE A TO D AND D TO A CONVERTERS MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 10%	UYA-4 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
LOCALIZE/ISOLATE CARD PUNCH MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 25%	UYK-5 UYK-20 LHA NTDS-CV USQ-20
LOCALIZE/ISOLATE CARD READER MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 18%	UYK-5 UYK-20 LHA NTDS-CV USQ-20
LOCALIZE/ISOLATE MAGNETIC TAPE CONTROLLER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 30%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20


TIME CONSUMING DS TASKS
CALIBRATE/ALIGN/ADJUST DISPLAY CONSOLE
WRITE/REWRITE PROGRAMS (MAINTENANCE, OPERATIONAL)
DEBUG PROGRAMS (MAINTENANCE, OPERATIONAL)
CALIBRATE/ALIGN/ADJUST CARD READER
CLEAN DISPLAY CONSOLE
CALIBRATE/ALIGN/ADJUST CARD PUNCH
REMOVE/REPLACE COOLING CHILLED WATER SYSTEM PARTS
CALIBRATE/ALIGN/ADJUST PULSE AMPLIFIER-SYMBOL GENERATOR
MODIFY EQUIPMENT IN ACCORDANCE WITH SHIPALTS, ORDALTS, FIELD CHANGE ORDERS AND ELECTRONIC INFORMATION BULLETINS (EIBS)
LIMITED
PARTIAL
COMPETENT
SUPERIOR
TIME CONSUMING: 53% UYA-4 UYK-7 LHA NTDS-3 NTDS-CV
TIME CONSUMING: 50% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
TIME CONSUMING: 48% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
TIME CONSUMING: 47% UYK-5 UYK-20 LHA NTDS-CV USQ-20
TIME CONSUMING: 44% UYA-4 UYK-7 LHA NTDS-3 NTDS-CV
TIME CONSUMING: 42% UYK-5 UYK-20 LHA NTDS-CV USQ-20
TIME CONSUMING: 42% UYA-4 LHA NTDS-3 NTDS-CV USQ-20
TIME CONSUMING: 41% UYA-4 LHA NTDS-3 NTDS-CV
TIME CONSUMING: 40% UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20

TIME CONSUMING DS TASKS



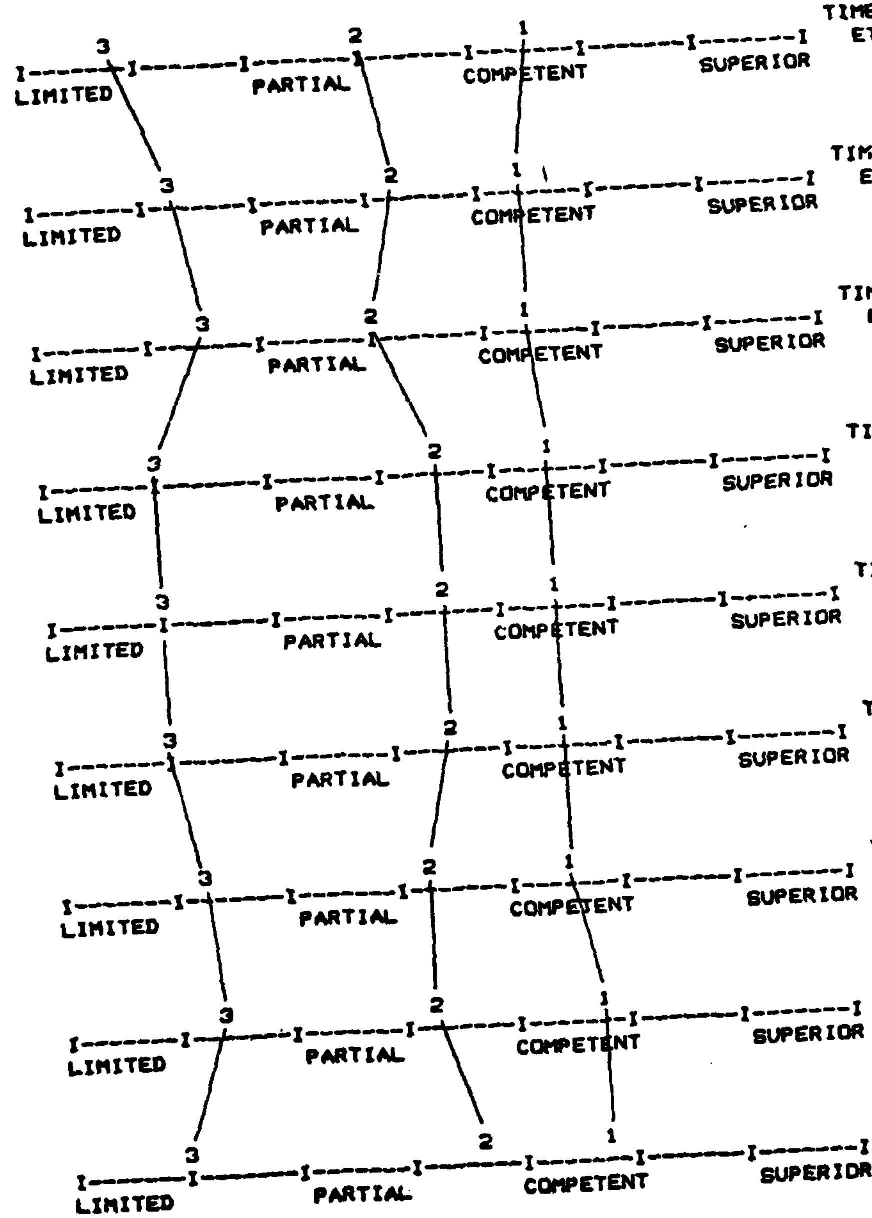
CLEAN COOLING CHILLED WATER SYSTEM	TIME CONSUMING: 40%	UYA-4 LHA NTDS-3 NTDS-CV USQ-20
ASSEMBLE/REPAIR CABLES AND TEST LEADS, SUCH AS CONNECTORS, PROBES, ETC.	TIME CONSUMING: 37%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
CALIBRATE/ALIGN/ADJUST DATA TERMINAL SET	TIME CONSUMING: 35%	UYA-4 UYK-7 LHA NTDS-3 NTDS-CV
REMOVE/REPLACE DIGITAL COMPUTER ELECTRONICS COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 35%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
CALIBRATE/ALIGN/ADJUST MAGNETIC TAPE TRANSPORT	TIME CONSUMING: 34%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
TEST NEW PROGRAMS (MAINTENANCE, OPERATIONAL)	TIME CONSUMING: 33%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
CALIBRATE/ALIGN/ADJUST DIGITAL COMPUTER ELECTRONICS	TIME CONSUMING: 33%	UYK-5 UYA-4 UYK-20 UYK-7 LHA NTDS-3 NTDS-CV USQ-20
CALIBRATE/ALIGN/ADJUST DISK FILE	TIME CONSUMING: 33%	UYK-5 UYK-20 LHA NTDS-CV USQ-20
TEST/INSPECT DISPLAY CONSOLE	TIME CONSUMING: 33%	UYA-4 UYK-7 LHA NTDS-3 NTDS-CV

DIFFICULT AND TIME-CONSUMING TASKS

ET(N) & ET(R)

DIFFICULT ET TASKS

LOCALIZE/ISOLATE IF MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 16%	ET(N)
CALIBRATE/ALIGN/ADJUST SYNCHRO/SERVO AMPLIFIERS	TIME CONSUMING: 42%	ET(R) ET(N)
CALIBRATE/ALIGN/ADJUST IF	TIME CONSUMING: 37%	ET(N)
LOCALIZE/ISOLATE MIXERS (FREQ TRANSLATION) MALFUNCTION TO A UNIT	TIME CONSUMING: 16%	ET(N)
LOCALIZE/ISOLATE MIXERS (FREQ TRANSLATION) MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 16%	ET(N)
CALIBRATE/ALIGN/ADJUST MIXERS (FREQ TRANSLATION)	TIME CONSUMING: 66%	ET(N)
LOCALIZE/ISOLATE IF MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 14%	ET(N)
ALIGN/ADJUST MECHANICAL LINKAGES AND GEAR TRAINS	TIME CONSUMING: 71%	ET(R) ET(N)
REMOVE/REPLACE IF COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 33%	ET(N)



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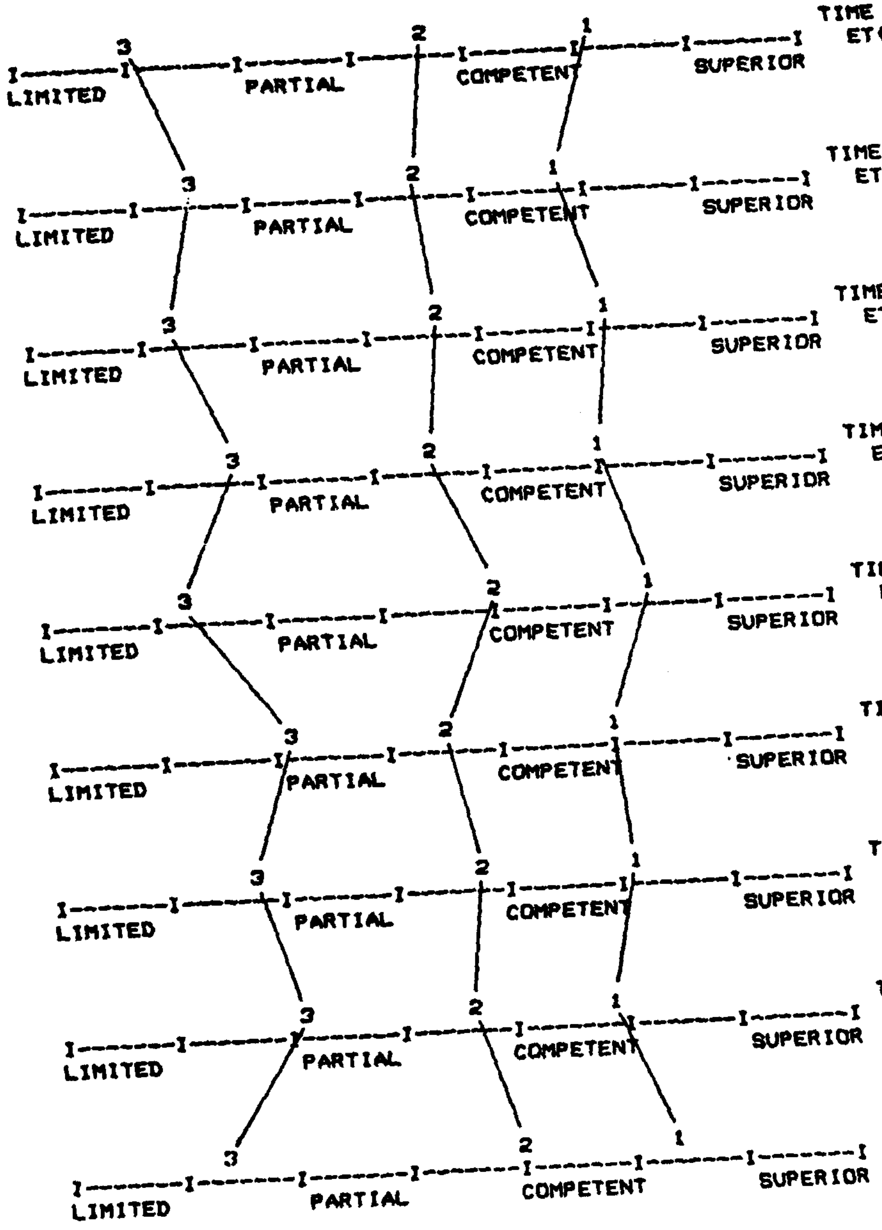
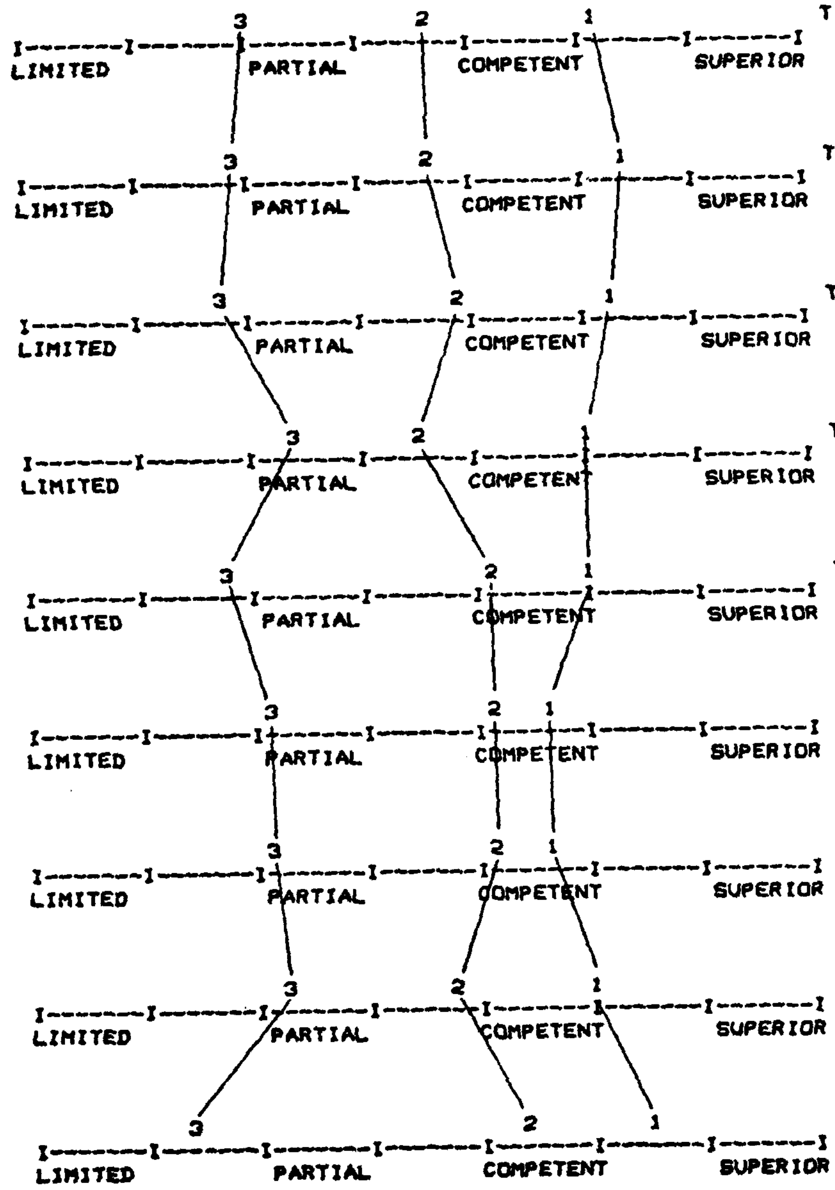
DIFFICULT ET TASKS



DIFFICULT ET TASKS	TIME CONSUMING
LOCALIZE/ISOLATE TEST EQUIPMENT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 0% ET(R) ET(N)
LOCALIZE/ISOLATE COMMUNICATION ANTENNA SYSTEMS MALFUNCTION TO THE COMPONENT LEVEL	TIME CONSUMING: 14% ET(N)
LOCALIZE/ISOLATE TEST EQUIPMENT MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 0% ET(R) ET(N)
LOCALIZE/ISOLATE MOTOR/GENERATORS	TIME CONSUMING: 0% ET(R) ET(N)
CALIBRATE/ALIGN/ADJUST TEST EQUIPMENT	TIME CONSUMING: 50% ET(R) ET(N)
TEST/INSPECT MOTOR/GENERATORS	TIME CONSUMING: 0% ET(R) ET(N)
LOCALIZE/ISOLATE COMMUNICATION ANTENNA SYSTEMS MALFUNCTION TO A UNIT	TIME CONSUMING: 14% ET(N)
CALIBRATE/ALIGN/ADJUST RF	TIME CONSUMING: 28% ET(N)
LOCALIZE/ISOLATE ELECTRONIC EQUIPMENT COOLING SYSTEM MALFUNCTION TO THE FAILED PART	TIME CONSUMING: 37% ET(R) ET(N)

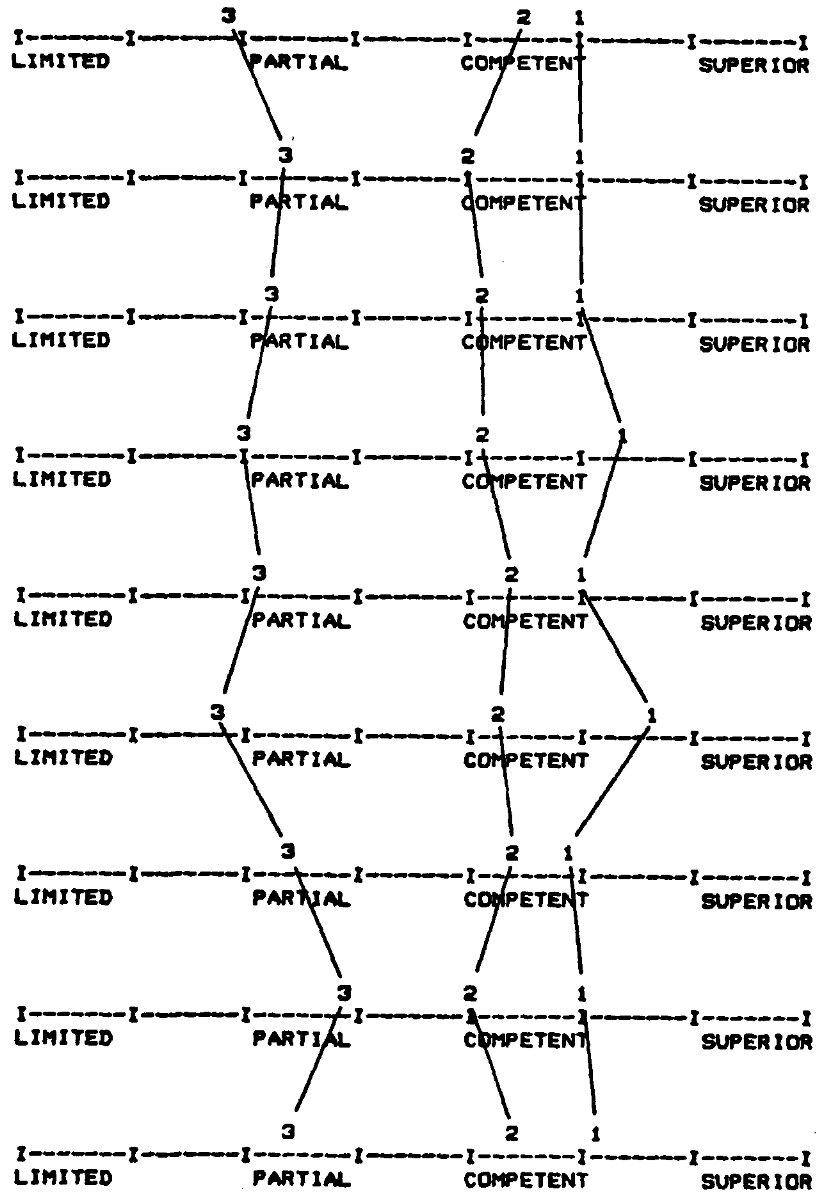
DIFFICULT ET TASKS

Task	
MODIFY EQUIPMENT IN ACCORDANCE WITH SHIPALTS, ORDALTS, FIELD CHANGE ORDERS AND ELECTRONIC INFORMATION BULLETINS (EIBS)	TIME CONSUMING: 25% ET(R) ET(N)
REMOVE/REPLACE SYNCHRO/SERVO AMPLIFIERS MODULES/CARDS	TIME CONSUMING: 14% ET(R) ET(N)
LOCALIZE/ISOLATE COMMUNICATION ANTENNA SYSTEMS MALFUNCTION TO A SUBSYSTEM	TIME CONSUMING: 14% ET(N)
CLEAN/LUBRICATE MOTOR/GENERATORS	TIME CONSUMING: 0% ET(R) ET(N)
LOCALIZE/ISOLATE RF MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 0% ET(N)
LOCALIZE/ISOLATE DEMODULATION MALFUNCTION TO A UNIT	TIME CONSUMING: 14% ET(N)
LOCALIZE/ISOLATE DEMODULATION MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 14% ET(N)
LOCALIZE/ISOLATE SYNCHRO/SERVO AMPLIFIERS MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 14% ET(R) ET(N)
LOCALIZE/ISOLATE RADAR POWER SUPPLY MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 16% ET(R)



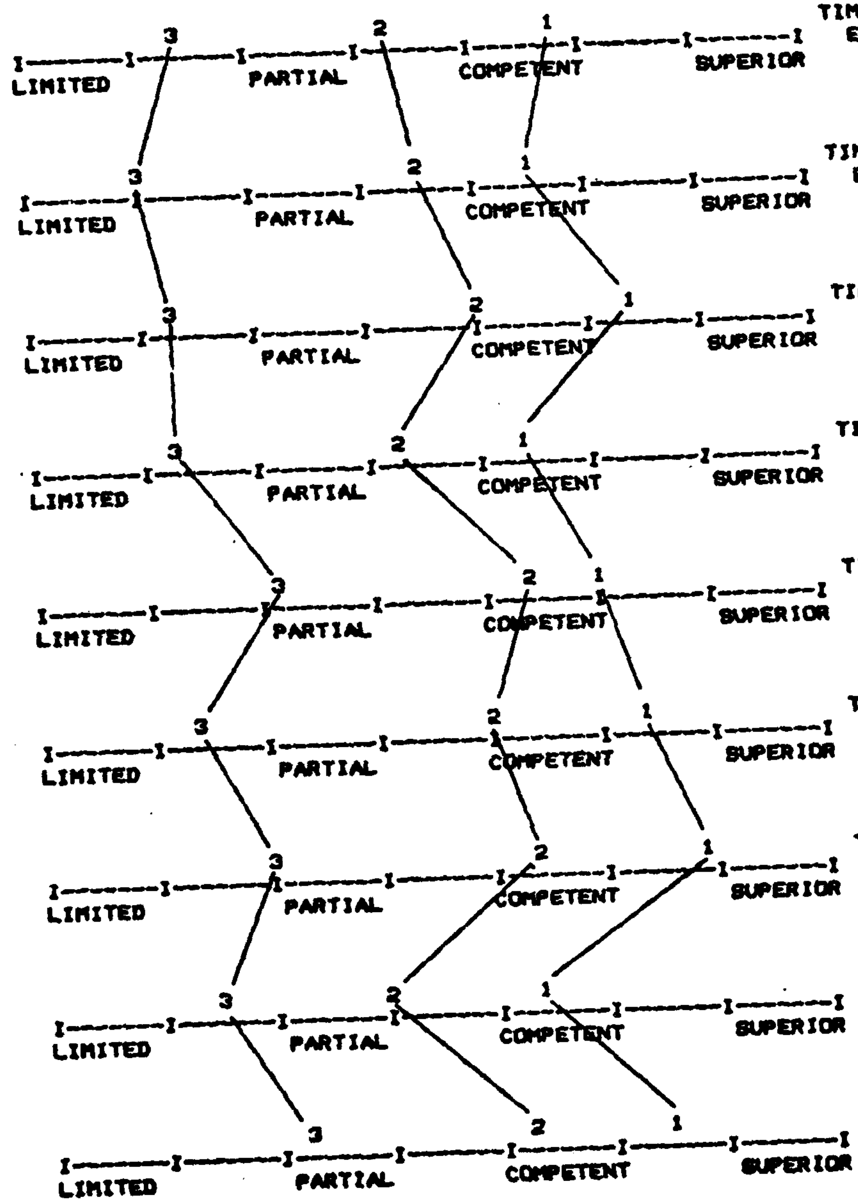
DIFFICULT ET TASKS

Task	Time consuming	
CALIBRATE/ALIGN/ADJUST MODULATION	TIME CONSUMING: 14%	ET(N)
LOCALIZE/ISOLATE IF MALFUNCTION TO A UNIT	TIME CONSUMING: 12%	ET(N)
LOCALIZE/ISOLATE RF MALFUNCTION TO A UNIT	TIME CONSUMING: 14%	ET(N)
LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A UNIT	TIME CONSUMING: 14%	ET(R) ET(N)
CALIBRATE/ALIGN/ADJUST DEMODULATION	TIME CONSUMING: 42%	ET(N)
TEST/INSPECT ELECTRONIC EQUIPMENT COOLING SYSTEM	TIME CONSUMING: 22%	ET(R) ET(N)
LOCALIZE/ISOLATE MODULATION MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 0%	ET(N)
CLEAN/LUBRICATE COMMUNICATION ANTENNA SYSTEMS	TIME CONSUMING: 14%	ET(N)
LOCALIZE/ISOLATE AUDIO MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 0%	ET(N)



TIME CONSUMING ET TASKS

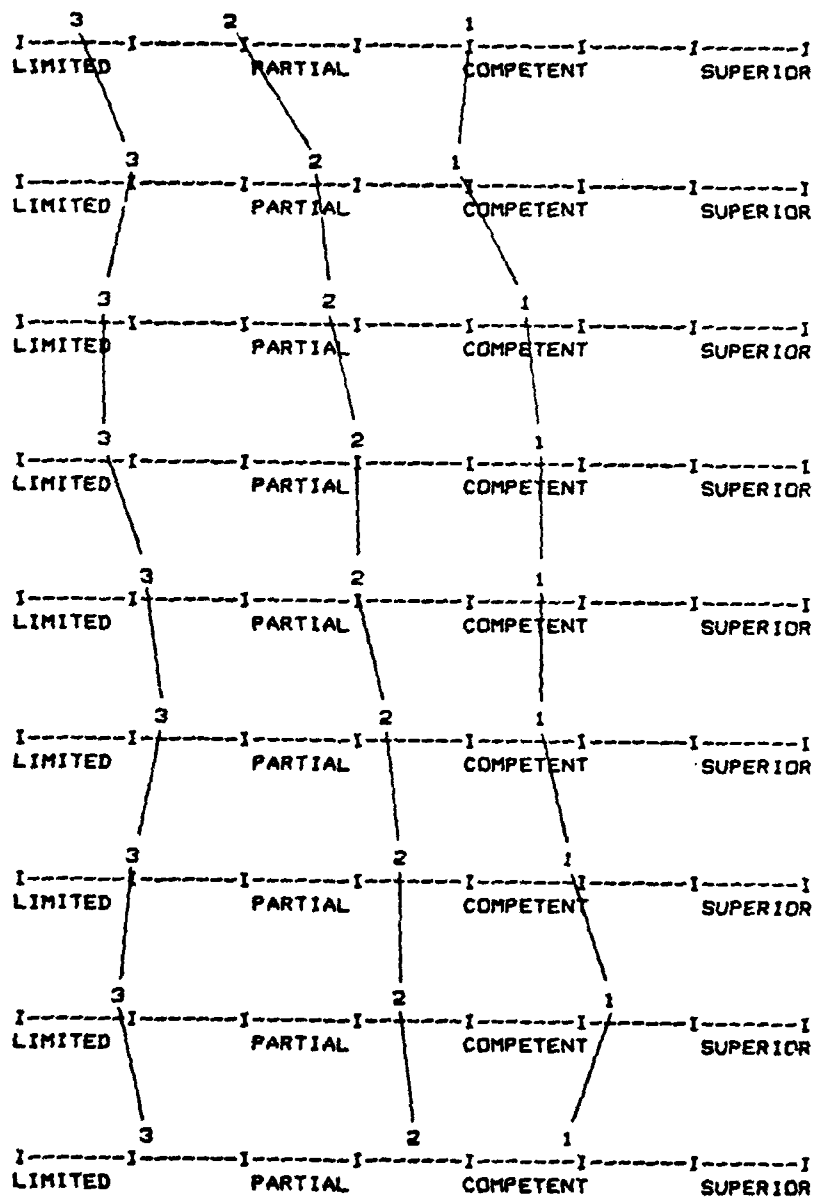
ALIGN/ADJUST MECHANICAL LINKAGES AND GEAR TRAINS	TIME CONSUMING: 71% ET(R) ET(N)
CALIBRATE/ALIGN/ADJUST MIXERS (FREQ TRANSLATION)	TIME CONSUMING: 66% ET(N)
CALIBRATE/ALIGN/ADJUST TEST EQUIPMENT	TIME CONSUMING: 50% ET(R) ET(N)
CALIBRATE/ALIGN/ADJUST SYNCHRO/ SERVO AMPLIFIERS	TIME CONSUMING: 42% ET(R) ET(N)
CALIBRATE/ALIGN/ADJUST DEMODULATION	TIME CONSUMING: 42% ET(N)
LOCALIZE/ISOLATE ELECTRONIC EQUIPMENT COOLING SYSTEM MAL- FUNCTION TO THE FAILED PART	TIME CONSUMING: 37% ET(R) ET(N)
REMOVE/REPLACE ELECTRONIC EQUIP- MENT COOLING SYSTEM FAILED PART	TIME CONSUMING: 37% ET(R) ET(N)
CALIBRATE/ALIGN/ADJUST IF	TIME CONSUMING: 37% ET(N)
ASSEMBLE/REPAIR CABLES AND TEST LEADS, SUCH AS CONNECTORS, PROBES, ETC.	TIME CONSUMING: 35% ET(R) ET(N)



DIFFICULT AND TIME-CONSUMING TASKS

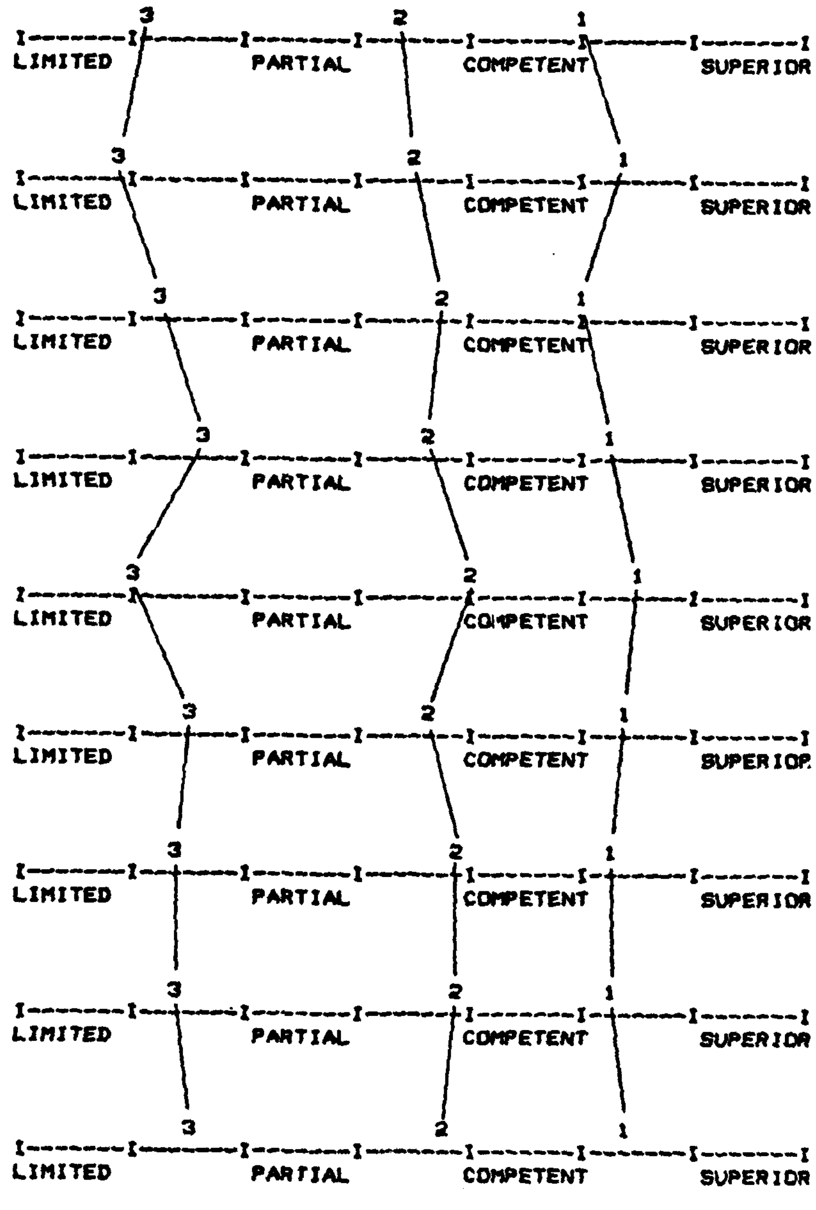
FT(M)

DIFFICULT FT TASKS



MAKE ALIGNMENT CORRECTIONS TO GUN MOUNTS/MISSILE LAUNCHERS	TIME CONSUMING: 81% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
INITIATE ELECTRONIC COUNTER COUNTERMEASURES (ECCM) ACTION FROM AURAL ANALYSIS	TIME CONSUMING: 13% MK-91 SPS-48 MK-74 SPS-52
DETERMINE BATTERY ALIGNMENT ERROR	TIME CONSUMING: 53% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
ANALYZE/ANNOTATE SYSTEMS TEST DATA	TIME CONSUMING: 37% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CHECK BATTERY ALIGNMENT (BORESIGHT)	TIME CONSUMING: 66% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
ALIGN/ADJUST MECHANICAL LINKAGES AND GEAR TRAINS	TIME CONSUMING: 62% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE TARGET DESIGNATION EQUIPMENT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 28% MK-77 SPS-48 MK-74 MK-76 SPS-52
COORDINATE WEAPON SYSTEMS TESTS	TIME CONSUMING: 63% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE TARGET DESIGNATION EQUIPMENT MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 19% MK-77 SPS-48 MK-74 MK-76 SPS-52

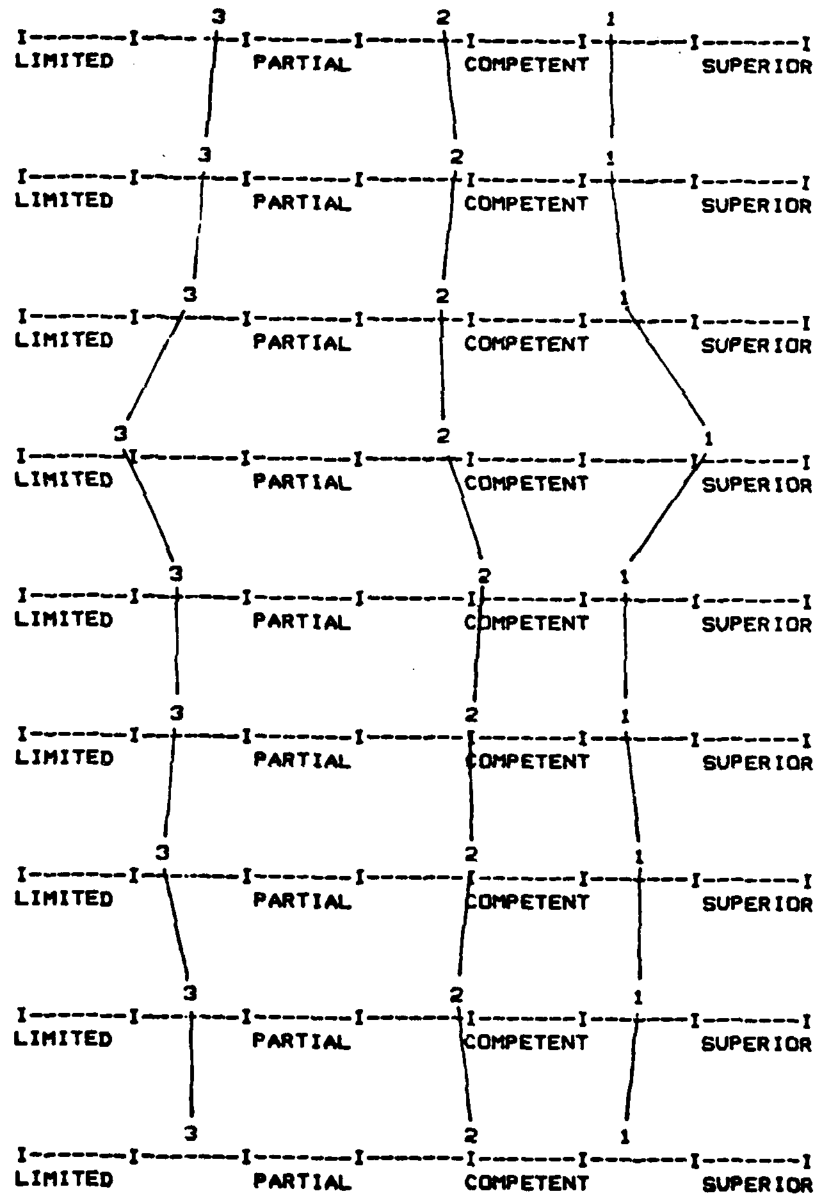
DIFFICULT FT TASKS



CALIBRATE/ALIGN/ADJUST TARGET DESIGNATION EQUIPMENT	TIME CONSUMING: 38%	MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE STABLE ELEMENTS/ STABLE VERTICALS MALFUNCTION TO THE COMPONENT LEVEL	TIME CONSUMING: 27%	MK-77 MK-74 SPS-52
LOCALIZE/ISOLATE RADAR RANGING UNITS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 48%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE TARGET DESIGNATION EQUIPMENT MALFUNCTION TO A UNIT	TIME CONSUMING: 28%	MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE STABLE ELEMENTS/ STABLE VERTICAL COMPONENTS	TIME CONSUMING: 40%	MK-77 MK-74 SPS-52
CALIBRATE/ALIGN/ADJUST RADAR RANGING UNITS	TIME CONSUMING: 46%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE RADAR ANTENNAS/ DRIVE SYSTEMS COMPONENTS	TIME CONSUMING: 56%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR VIDEO PROCESSING UNIT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 42%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR SIGNAL PROCESSING EQUIPMENT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 40%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52

DIFFICULT FT TASKS

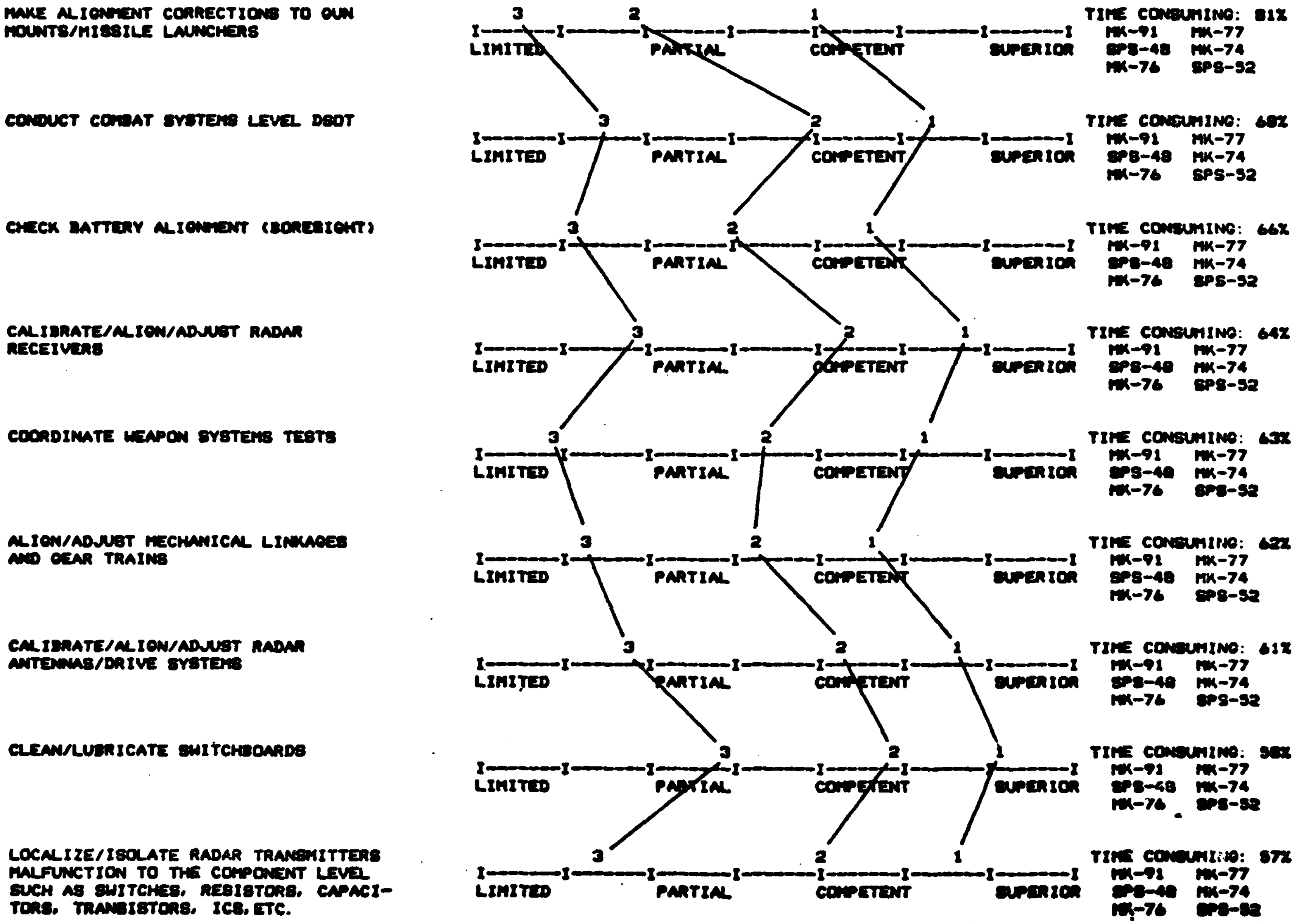
Task	Time consuming	Systems
LOCALIZE/ISOLATE FIRE CONTROL DIRECTORS MALFUNCTION TO THE COMPONENT	53%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52
LOCALIZE/ISOLATE RADAR RANGING UNITS MALFUNCTION TO THE MODULE/CARD LEVEL	44%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52
CHANGE SYSTEM CONFIGURATION BY PATCHING OR BY SWITCHBOARD CHANGES	34%	MK-77, SPS-48, MK-74, MK-76, SPS-52
CONDUCT HORIZON CHECKS	44%	MK-74, MK-76, SPS-52
LOCALIZE/ISOLATE RADAR VIDEO INDICATING DISPLAY MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	40%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52
MODIFY EQUIPMENT IN ACCORDANCE WITH SHIPALTS, ORDALTS, FIELD CHANGE ORDERS AND ELECTRONIC INFORMATION BULLETINS (EIBS)	48%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52
LOCALIZE/ISOLATE RADAR TRACKING UNIT MALFUNCTION TO THE MODULE/CARD LEVEL	30%	MK-91, MK-77, MK-74, MK-76, SPS-52
LOCALIZE/ISOLATE RADAR SIGNAL PROCESSING EQUIPMENT MALFUNCTION TO THE MODULE/CARD LEVEL	38%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52
CONDUCT COMBAT SYSTEMS LEVEL DSOT	68%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52



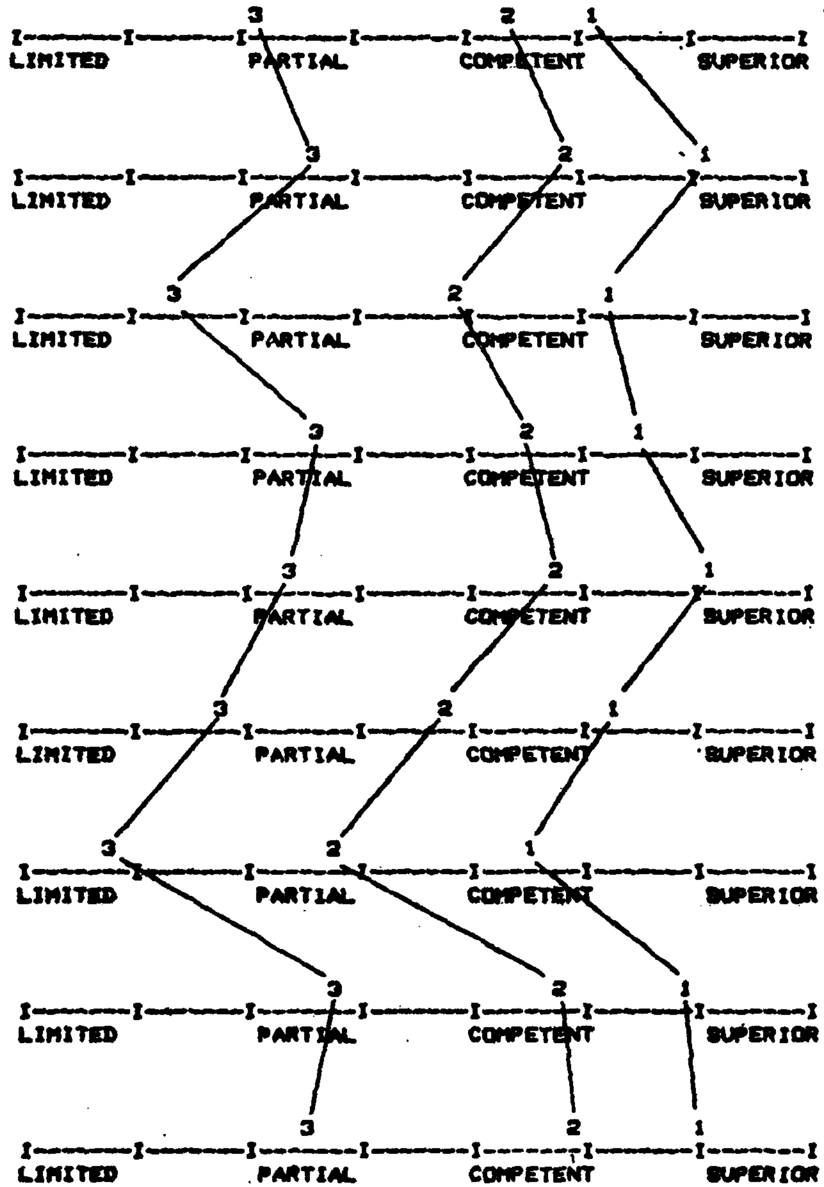
DIFFICULT FT TASKS

DIFFICULT FT TASKS	LIMITED	PARTIAL	COMPETENT	SUPERIOR	TIME CONSUMING	
LOCALIZE/ISOLATE RADAR TRANSMITTERS MALFUNCTION TO THE COMPONENT LEVEL SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3		2	1	57%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52
LOCALIZE/ISOLATE RADAR VIDEO PROCESSING UNIT MALFUNCTION TO THE MODULE/CARD LEVEL	3		2	1	42%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52
CALIBRATE/ALIGN/ADJUST FIRE CONTROL DIRECTORS	3		2	1	45%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52
CALIBRATE/ALIGN/ADJUST SYNCHRO-SERVO SYSTEMS	3		2	1	42%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52
LOCALIZE/ISOLATE RADAR TRACKING UNIT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3		2	1	36%	MK-91, MK-77, MK-74, MK-76, SPS-52
LOCALIZE/ISOLATE FIRE CONTROL COMPUTERS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3		2	1	37%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52
LOCALIZE/ISOLATE FIRE CONTROL COMPUTERS MALFUNCTION TO THE MODULE/CARD LEVEL	3		2	1	36%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52
LOCALIZE/ISOLATE SWITCHBOARDS MALFUNCTION TO THE COMPONENT LEVEL	3		2	1	50%	MK-91, MK-77, SPS-48, MK-74, MK-76, SPS-52
ANALYZE TARGETS BY AURAL MEANS	3		2	1	6%	MK-91, SPS-48, MK-74, SPS-52

TIME CONSUMING FT TASKS

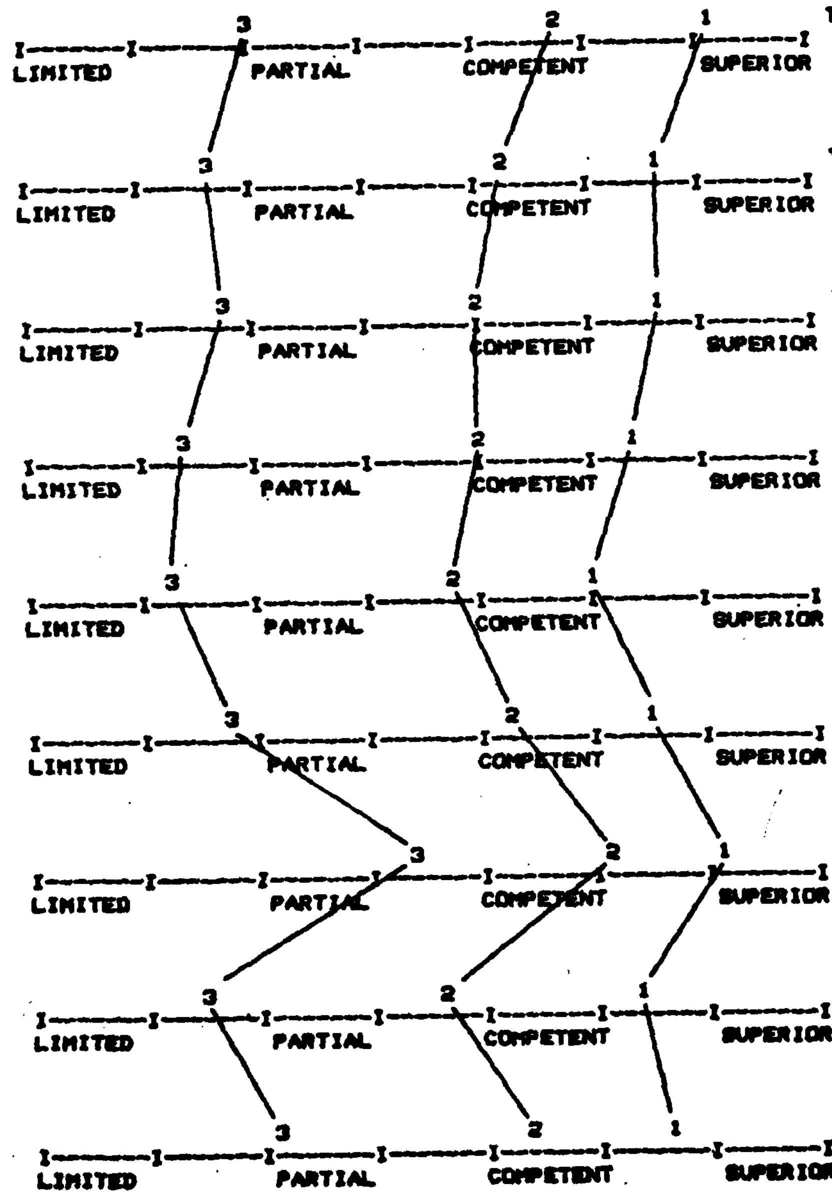


TIME CONSUMING FT TASKS



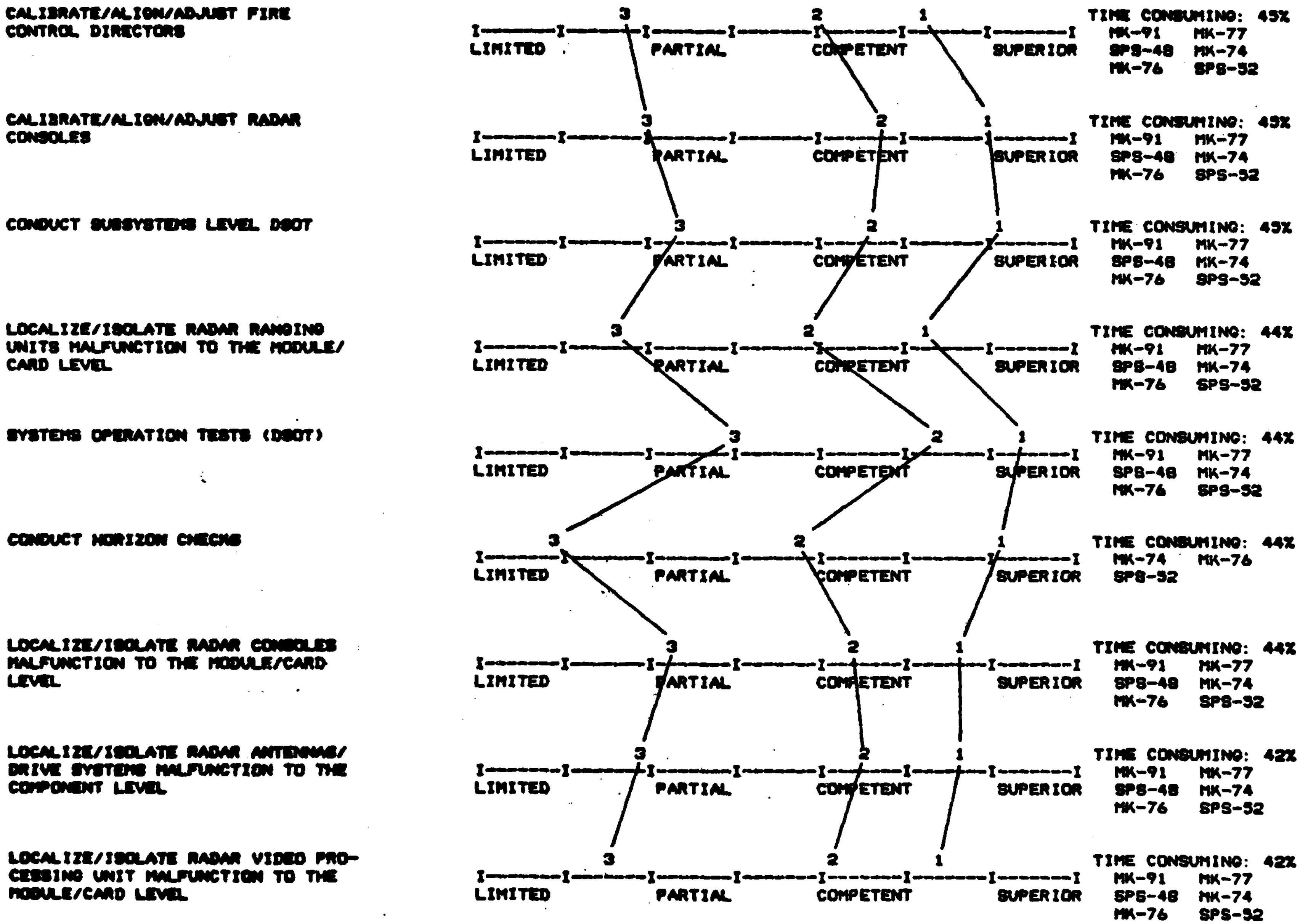
CLEAN DESSICATED AIR/COOLANT SYSTEMS	TIME CONSUMING: 57%	MK-76
REMOVE/REPLACE DESSICATED AIR/ COOLANT SYSTEMS COMPONENTS	TIME CONSUMING: 57%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE RADAR ANTENNAS/ DRIVE SYSTEMS COMPONENTS	TIME CONSUMING: 56%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE FIRE CONTROL DIRECTORS COMPONENTS	TIME CONSUMING: 56%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE CONTINUOUS WAVE ILLUMINATION (CWI) COMPONENTS	TIME CONSUMING: 54%	MK-77 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE FIRE CONTROL DIRECTORS MALFUNCTION TO THE COMPONENT	TIME CONSUMING: 53%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
DETERMINE BATTERY ALIGNMENT ERROR	TIME CONSUMING: 53%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE SWITCHBOARDS COMPONENTS	TIME CONSUMING: 51%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
ASSEMBLE/REPAIR CABLES AND TEST LEADS, SUCH AS CONNECTORS, PROBES, ETC.	TIME CONSUMING: 51%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52

TIME CONSUMING FT TASKS

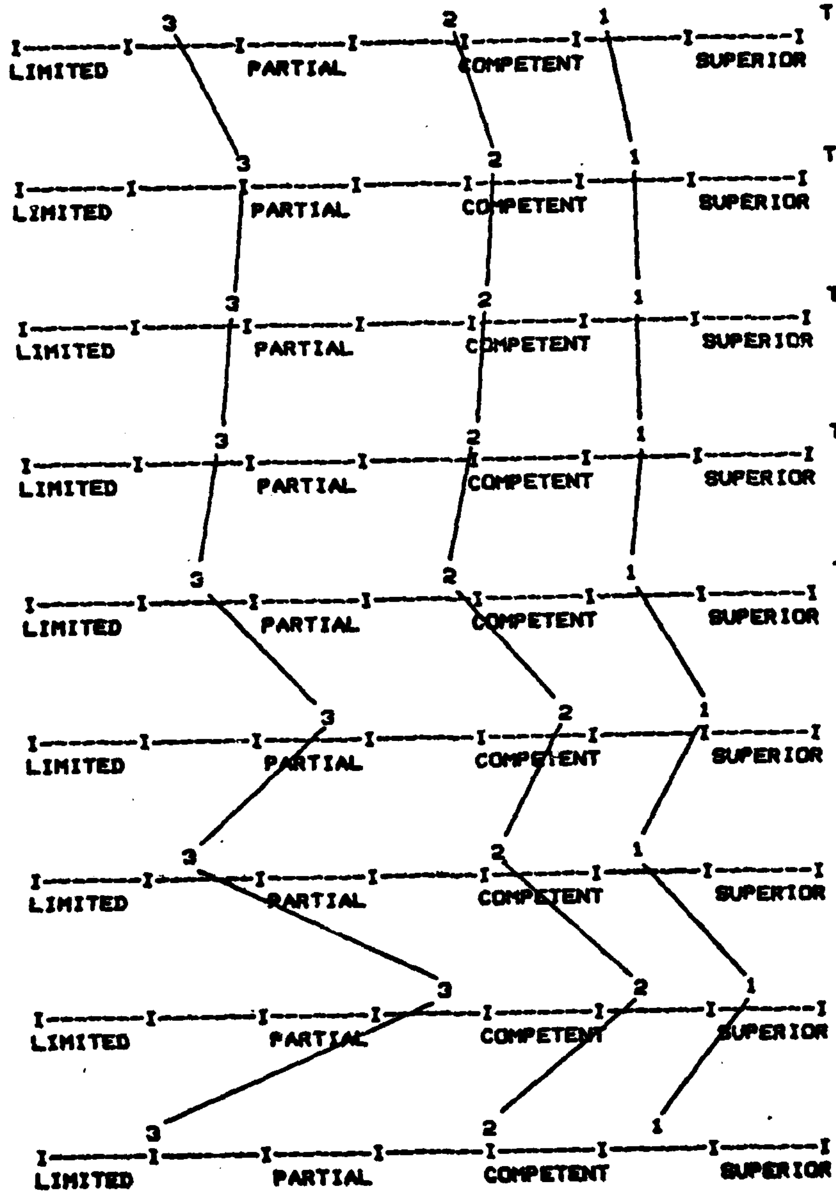


CALIBRATE/ALIGN/ADJUST RADAR TRANSMITTERS	TIME CONSUMING: 50%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST RADAR VIDEO PROCESSING UNIT	TIME CONSUMING: 50%	MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE SWITCHBOARDS MALFUNCTION TO THE COMPONENT LEVEL	TIME CONSUMING: 50%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
MODIFY EQUIPMENT IN ACCORDANCE WITH SHIPALTS, ORDALTS, FIELD CHANGE ORDERS AND ELECTRONIC INFORMATION BULLETINS (EIBS)	TIME CONSUMING: 48%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR RANGING UNITS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 48%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR CONSOLES MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 47%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CLEAN/LUBRICATE FIRE CONTROL DIRECTORS	TIME CONSUMING: 46%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST RADAR RANGING UNITS	TIME CONSUMING: 46%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST RADAR TRACKING UNIT	TIME CONSUMING: 45%	MK-91 MK-77 MK-74 MK-76 SPS-52

TIME CONSUMING FT TASKS



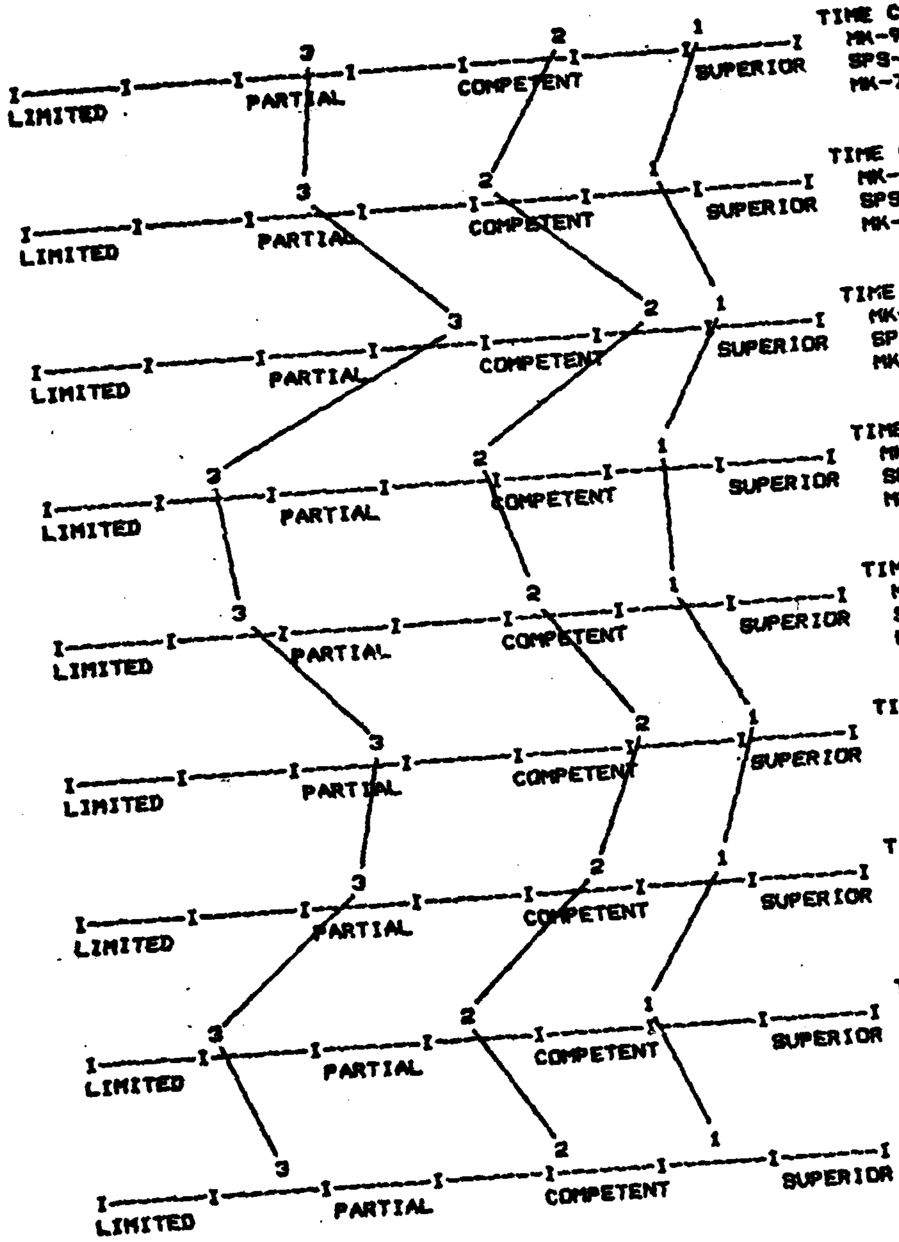
TIME CONSUMING FT TASKS



LOCALIZE/ISOLATE RADAR VIDEO PROCESSING UNIT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 42%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST BEARING-RANGE INDICATORS	TIME CONSUMING: 42%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR VIDEO INDICATING DISPLAY MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 42%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST SYNCHRO-SERVO SYSTEMS	TIME CONSUMING: 42%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR SIGNAL PROCESSING EQUIPMENT MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, R' SISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 40%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE SIGNAL PROCESSING EQUIPMENT COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 40%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR VIDEO INDICATING DISPLAY MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 40%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CLEAN/LUBRICATE RADAR ANTENNAS/DRIVE SYSTEMS	TIME CONSUMING: 40%	MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE STABLE ELEMENTS/STABLE VERTICAL COMPONENTS	TIME CONSUMING: 40%	MK-77 MK-74 SPS-52

TIME CONSUMING FT TASKS

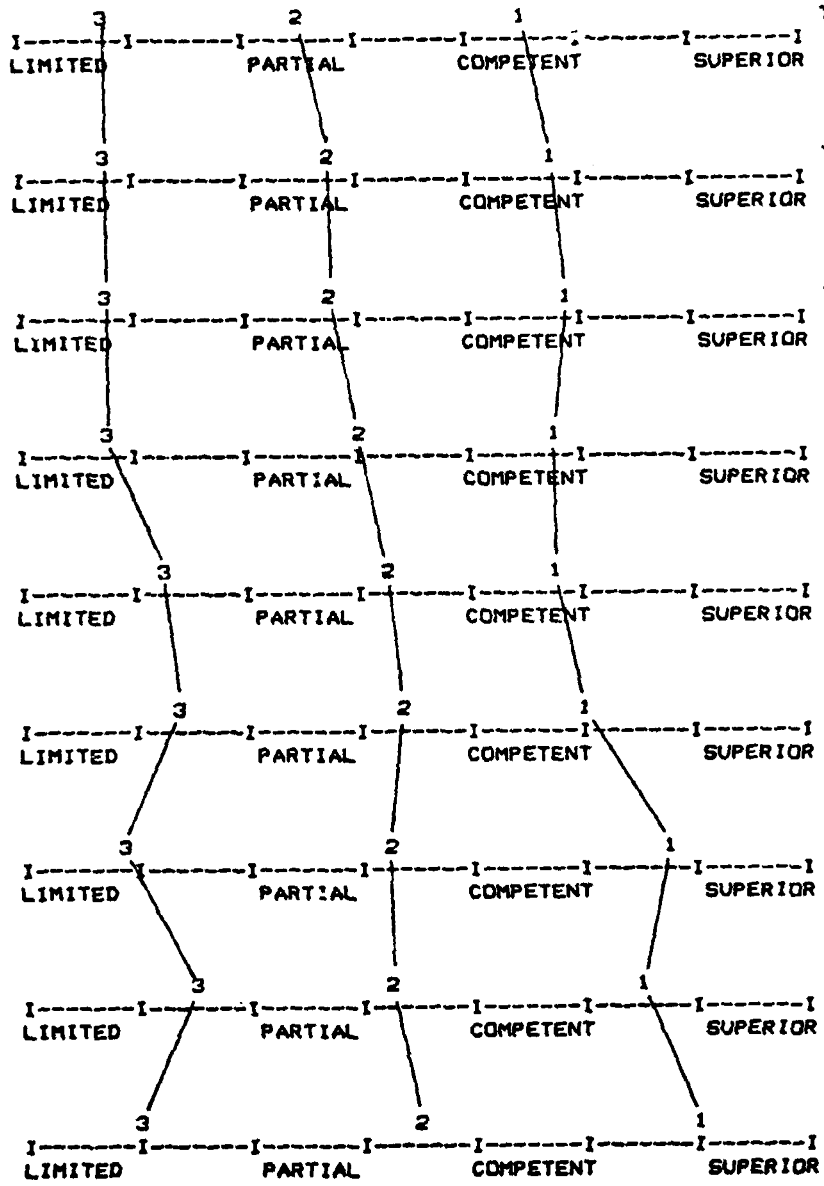
Task	Time consuming
CALIBRATE/ALIGN/ADJUST DESSICATED AIR COOLANT SYSTEMS	TIME CONSUMING: 39% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST SWITCHBOARDS	TIME CONSUMING: 39% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CLEAN RADAR TRANSMITTERS	TIME CONSUMING: 38% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE RADAR SIGNAL PROCESSING EQUIPMENT MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 38% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST RADAR SIGNAL PROCESSING EQUIPMENT	TIME CONSUMING: 38% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
REMOVE/REPLACE RADAR CONSOLES COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 38% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST RADAR VIDEO INDICATING DISPLAY	TIME CONSUMING: 38% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52
CALIBRATE/ALIGN/ADJUST TARGET DESIGNATION EQUIPMENT	TIME CONSUMING: 38% MK-77 SPS-48 MK-74 MK-76 SPS-52
LOCALIZE/ISOLATE FIRE CONTROL COMPUTERS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS,	TIME CONSUMING: 37% MK-91 MK-77 SPS-48 MK-74 MK-76 SPS-52



DIFFICULT AND TIME-CONSUMING TASKS

RM

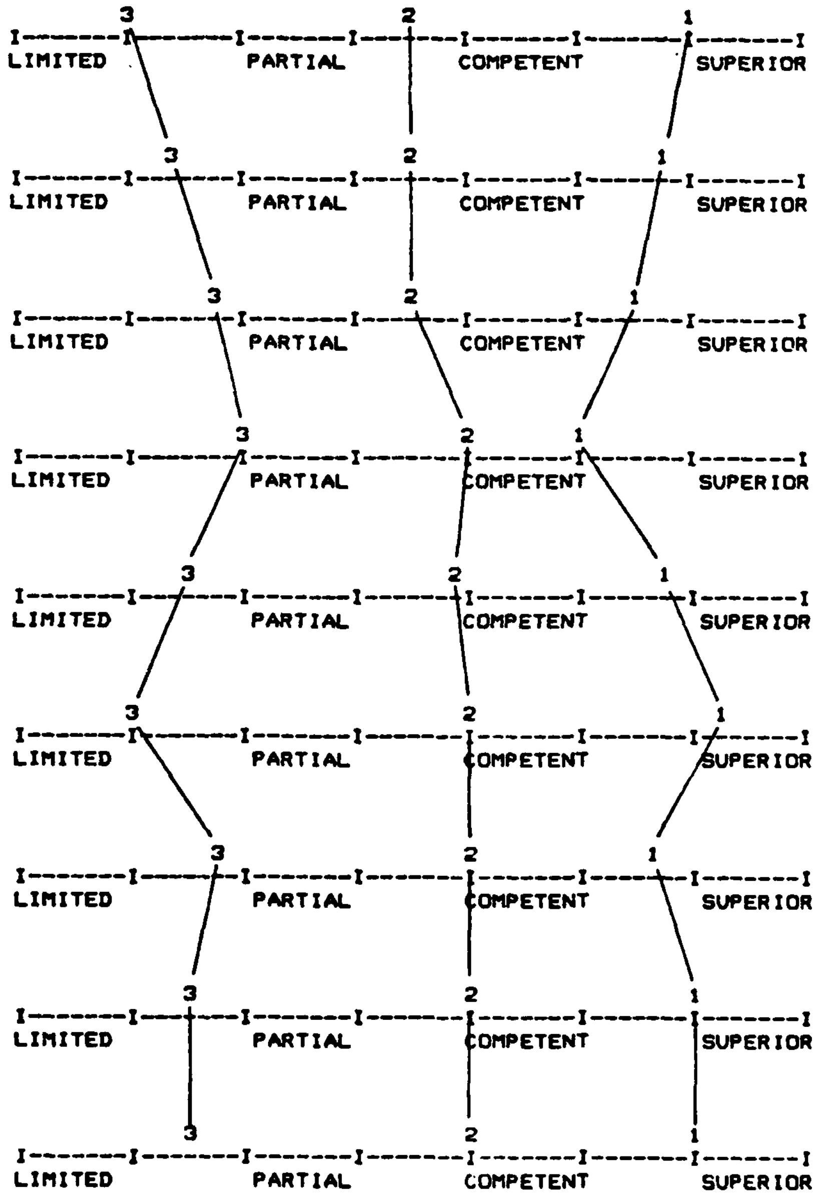
DIFFICULT RM TASKS



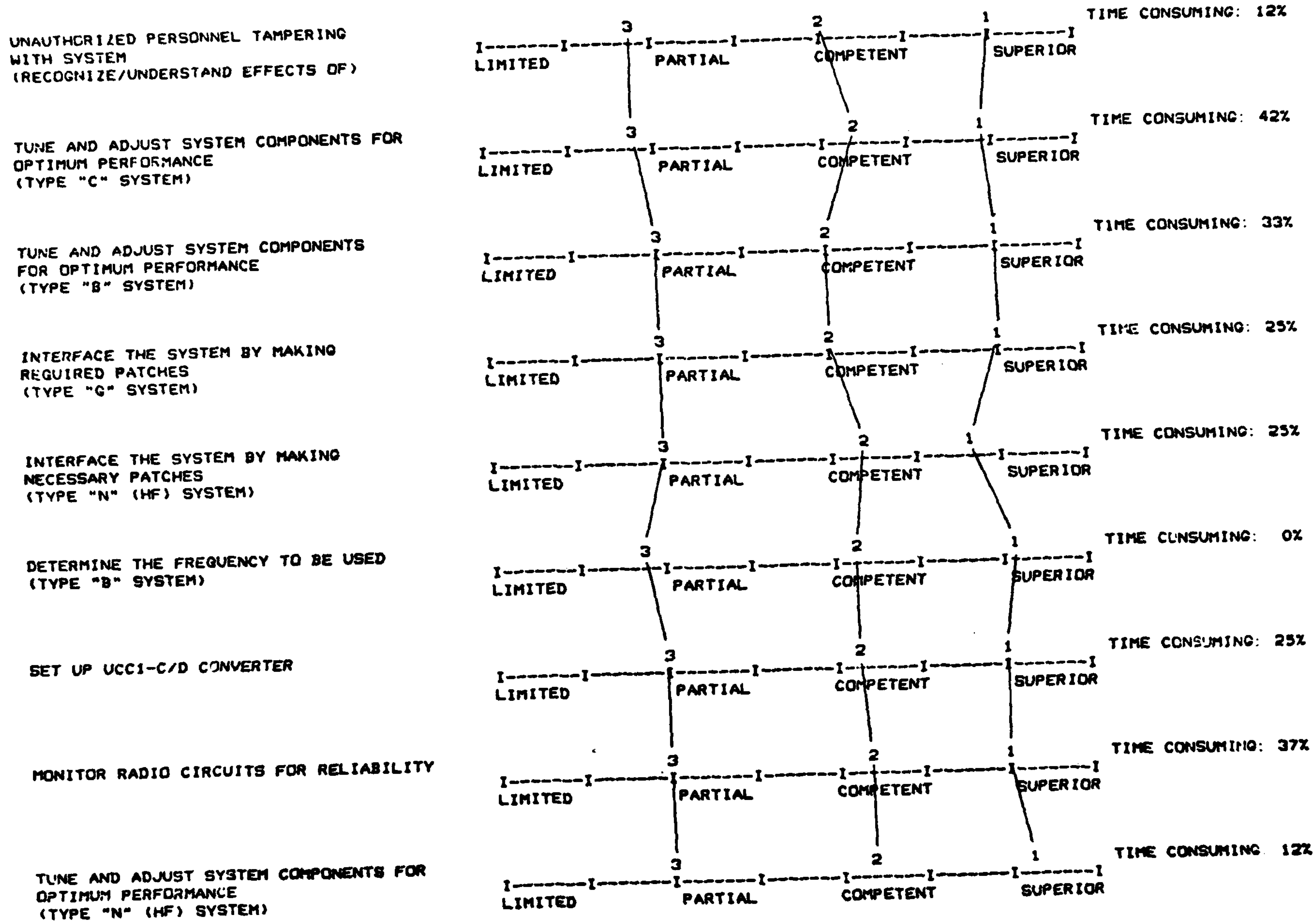
IDENTIFY AND REPORT INTRUSION, ... AND INTERFERENCE (MIJI) ON RADIO ... EQUIPMENT	TIME CONSUMING: 12%
RESEARCH TECHNICAL PUBLICATIONS TO FIND APPROPRIATE SCHEMATICS/LOGIC DIAGRAMS/ TABLES TROUBLESHOOTING CHARTS/MAINTENANCE INFORMATION/PART NUMBERS FOR SPECIFIC PIECES OF EQUIPMENT	TIME CONSUMING: 57%
IDENTIFY STANDARD ELECTRONIC/MECHANICAL SYMBOLS AS USED ON SCHEMATICS, LOGIC DIAGRAMS, FLOW CHARTS, ETC.	TIME CONSUMING: 42%
USE TEST EQUIPMENT TO INJECT SIGNALS AND/OR TAKE READINGS	TIME CONSUMING: 12%
LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A SUBSYSTEM	TIME CONSUMING: 25%
LOCALIZE/ISOLATE EQUIPMENT MALFUNCTION TO A UNIT	TIME CONSUMING: 25%
USE TRACER PROCEDURES WHEN REQUIRED	TIME CONSUMING: 14%
LOCALIZE/ISOLATE ANTENNAS MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS INSULATORS, PEDESTALS, BASES, CONDUCTORS, ETC.	TIME CONSUMING: 57%
REVIEW COMMUNICATION SHIFT, COMMUNICATION GUARD MESSAGES	TIME CONSUMING: 12%

DIFFICULT RM TASKS

Task	Time consuming
PERFORM REQUIRED SERVICE ACTION ON MESSAGES AS NEEDED	TIME CONSUMING: 25%
ADVERSE ATMOSPHERIC CONDITIONS (RECOGNIZE/UNDERSTAND EFFECTS OF)	TIME CONSUMING: 0%
ASSEMBLE/REPAIR CABLES AND TEST LEADS, SUCH AS CONNECTORS, PROBES, ETC.	TIME CONSUMING: 42%
DETERMINE THE FREQUENCY TO BE USED (TYPE "D" SYSTEM)	TIME CONSUMING: 12%
INTERFACE THE SYSTEM BY MAKING REQUIRED PATCHES (TYPE "C" SYSTEM)	TIME CONSUMING: 28%
INTERFACE THE SYSTEM BY MAKING REQUIRED PATCHES (TYPE "D" SYSTEM)	TIME CONSUMING: 25%
CHANGE SYSTEM CONFIGURATION BY PATCHING OR BY SWITCHBOARD CHANGES	TIME CONSUMING: 25%
CHECK FREQUENCIES FOR USABILITY (GAP)	TIME CONSUMING: 50%
OPEN PATCH CORD (RECOGNIZE/UNDERSTAND EFFECTS OF)	TIME CONSUMING: 25%

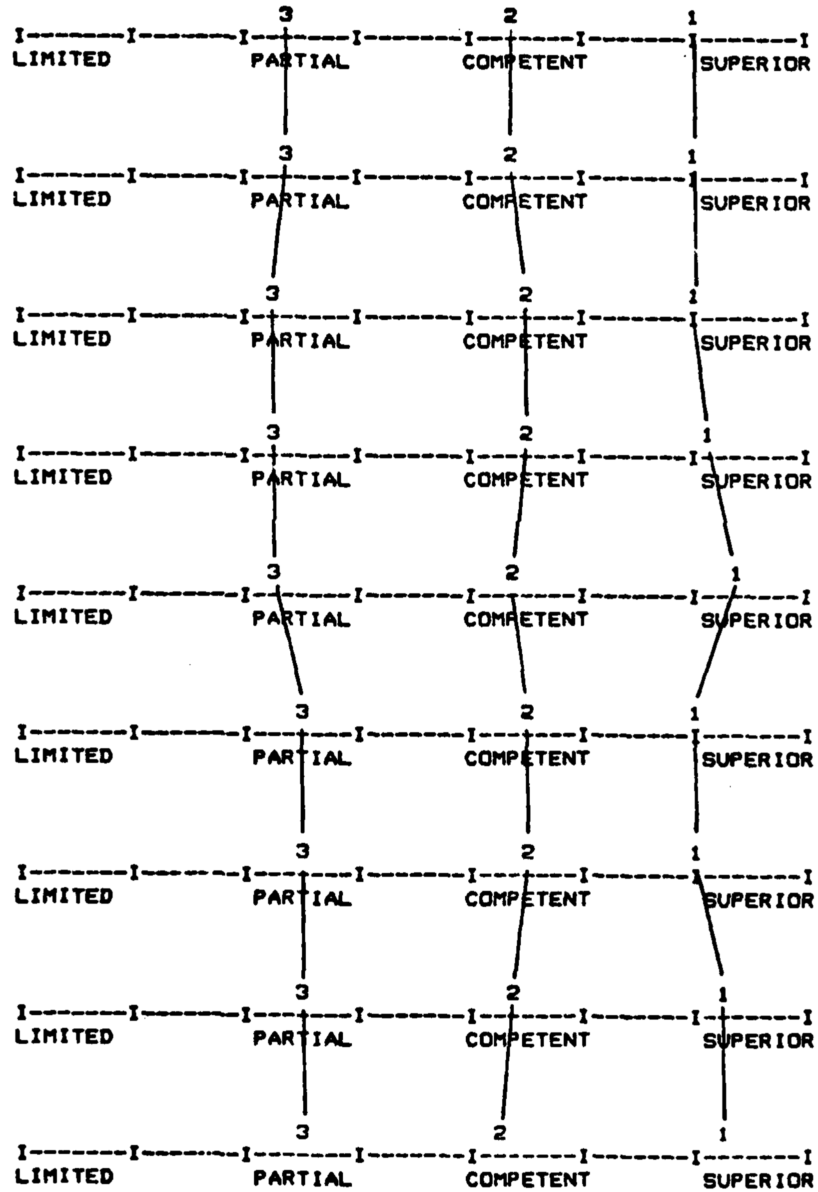


DIFFICULT RM TASKS

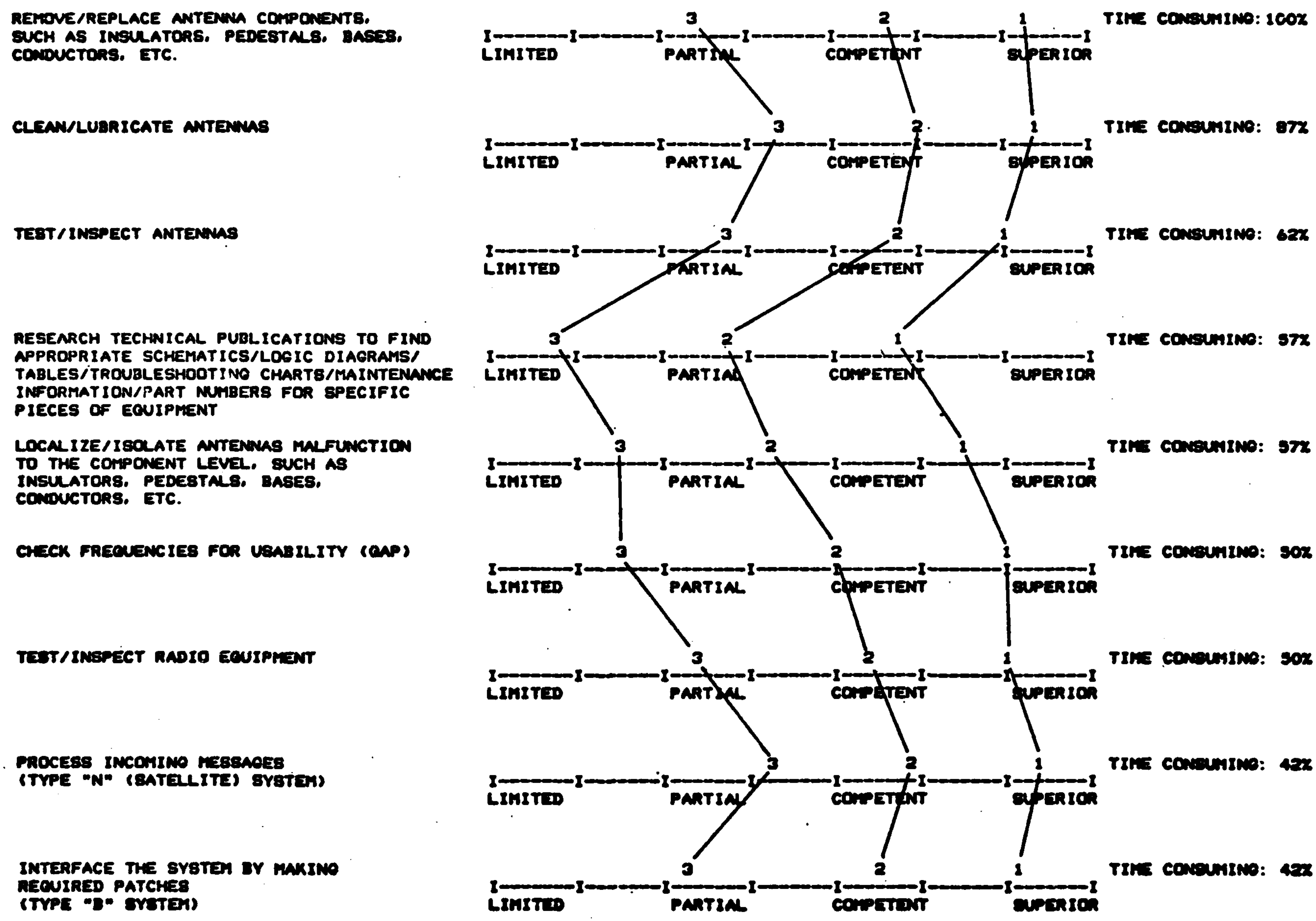


DIFFICULT RM TASKS

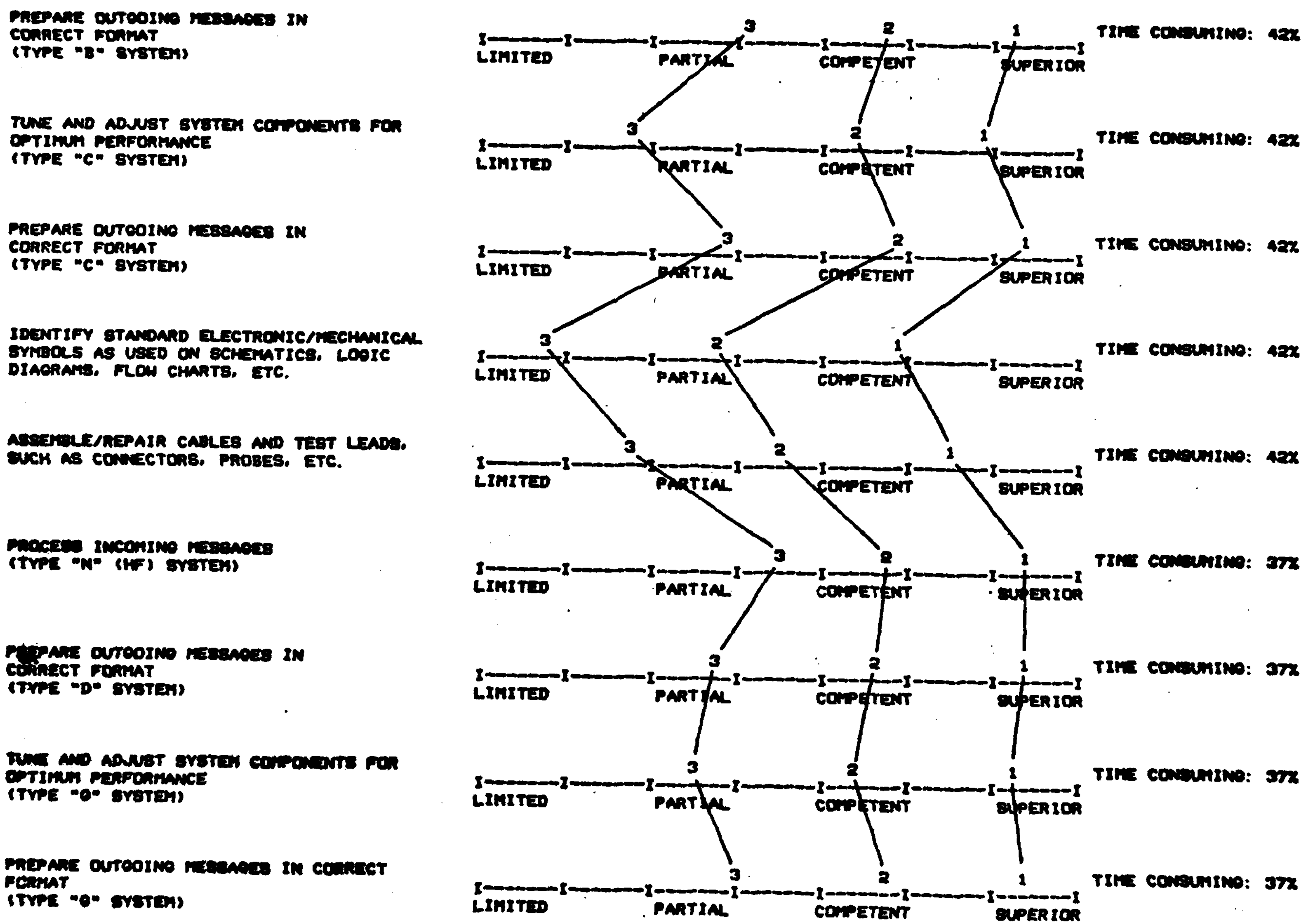
ANALYZE EQUIPMENT FRONT PANEL INDICATORS FOR FAULT DETECTION	TIME CONSUMING: 25%
TEST/INSPECT RADIO EQUIPMENT	TIME CONSUMING: 50%
TUNE TRANSCEIVERS	TIME CONSUMING: 12%
INTERFACE THE SYSTEM BY MAKING REQUIRED PATCHES (TYPE "B" SYSTEM)	TIME CONSUMING: 42%
SELECT EQUIPMENTS TO BE USED (TYPE "D" SYSTEM)	TIME CONSUMING: 0%
DETERMINE THE FREQUENCIES TO BE USED (TYPE "G" SYSTEM)	TIME CONSUMING: 12%
VARIATION IN PRIMARY POWER (RECOGNIZE/UNDERSTAND EFFECTS OF)	TIME CONSUMING: 0%
RECEIVE FLEET BROADCAST USING FREQUENCY DIVERSITY METHODS	TIME CONSUMING: 12%
DETERMINE SHIP(S) AND/OR STATION(S) TO BE TERMINATED WITH (TYPE "B" SYSTEM)	TIME CONSUMING: 0%



TIME CONSUMING RM TASKS



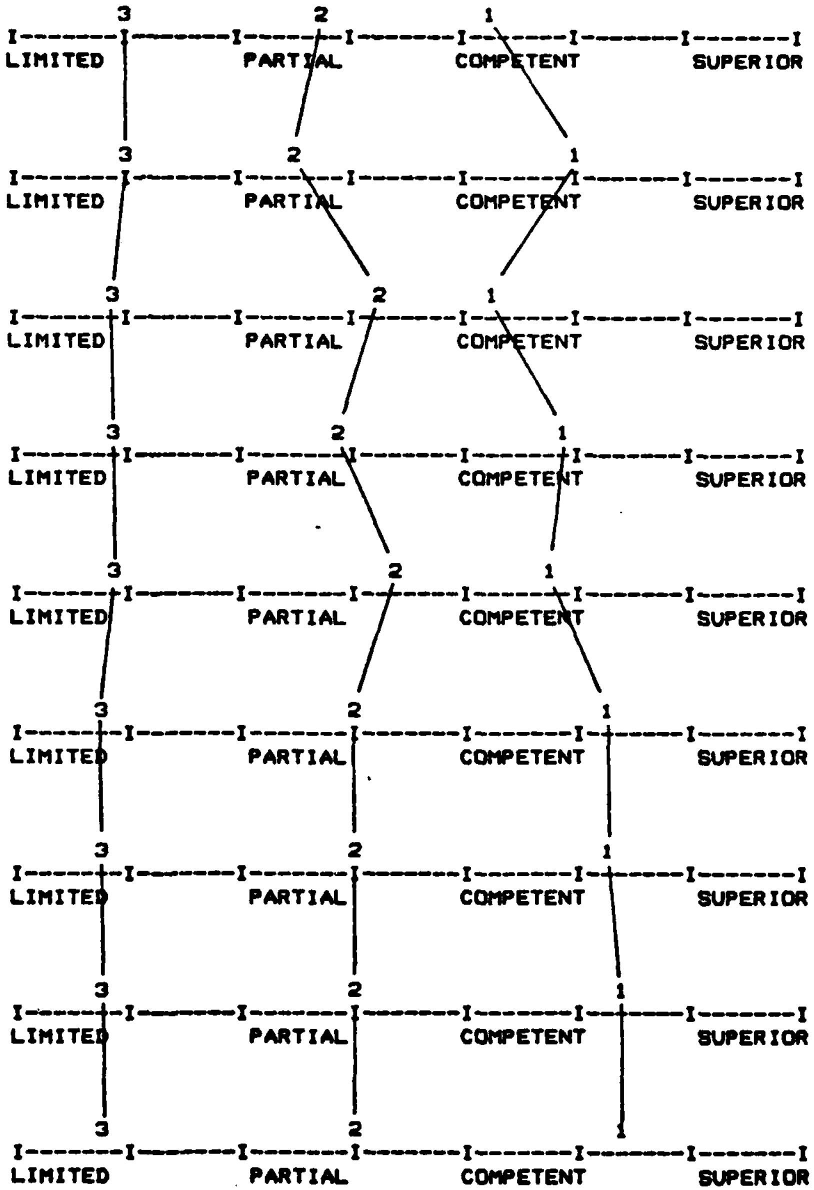
TIME CONSUMING RM TASKS



DIFFICULT AND TIME-CONSUMING TASKS
STG

DIFFICULT ST TASKS

CALCULATES COUNTER-DETECTION RANGES	TIME CONSUMING: 30%	SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE CONVERTER B-SCAN MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 16%	SQS-26
RECOMMENDS USE OF PRAIRIE MASKER SECURING NOISY EQUIPMENTS, AND ADJUSTMENTS IN MANEUVERING TO REDUCE DETECTABILITY	TIME CONSUMING: 18%	SQS-35 SQS-26 SQS-23
CONNS THE SHIP FROM UNDERWATER BATTERY (UB) PLOT DURING AN ASW ATTACK OR SIMULATED ASW ATTACK	TIME CONSUMING: 7%	SQS-35 SQS-26 SQS-23
CALCULATES PASSIVE FOM	TIME CONSUMING: 9%	SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE CONVERTER B-SCAN MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 0%	SQS-26
CALIBRATE/ALIGN/ADJUST SONAR MODULATOR-SCANNER	TIME CONSUMING: 16%	SQS-26 SQS-23
TEST/INSPECT CONVERTER B-SCAN	TIME CONSUMING: 16%	SQS-26
CALIBRATE/ALIGN/ADJUST CONVERTER B-SCAN	TIME CONSUMING: 33%	SQS-26



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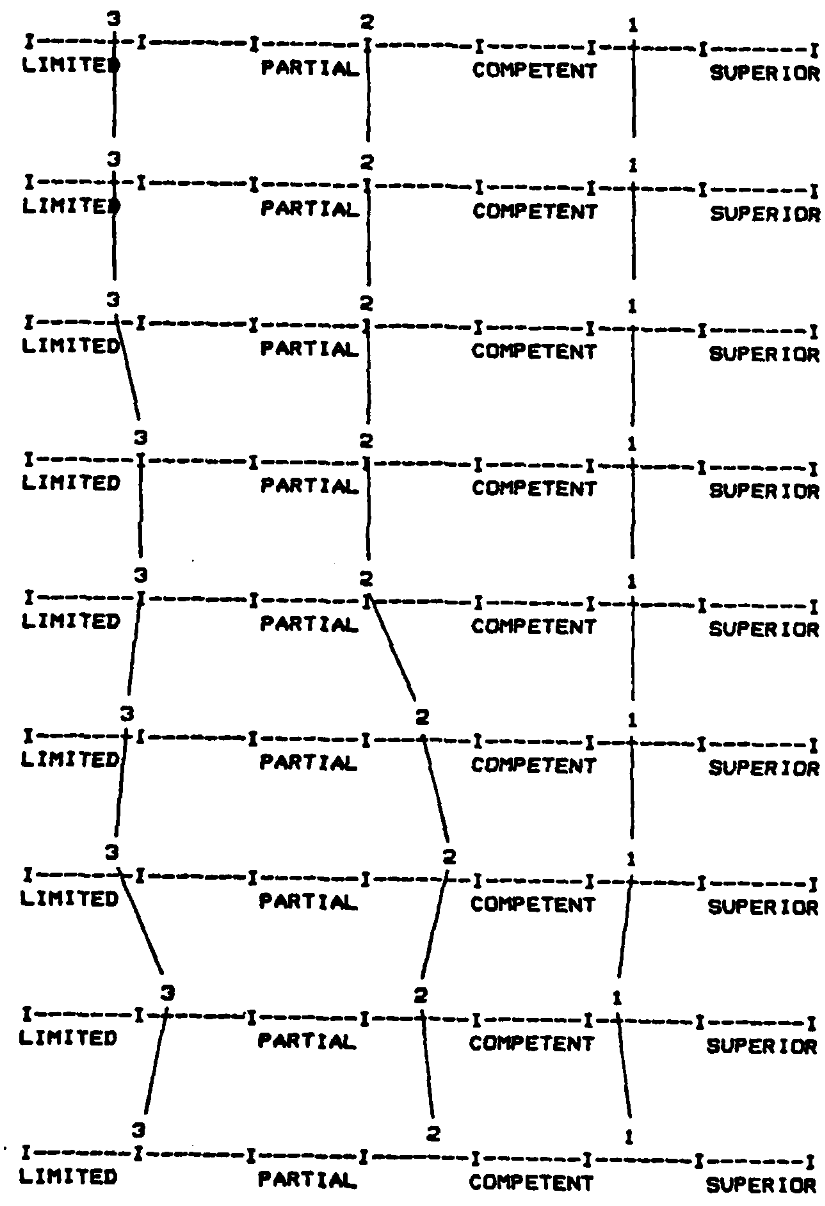
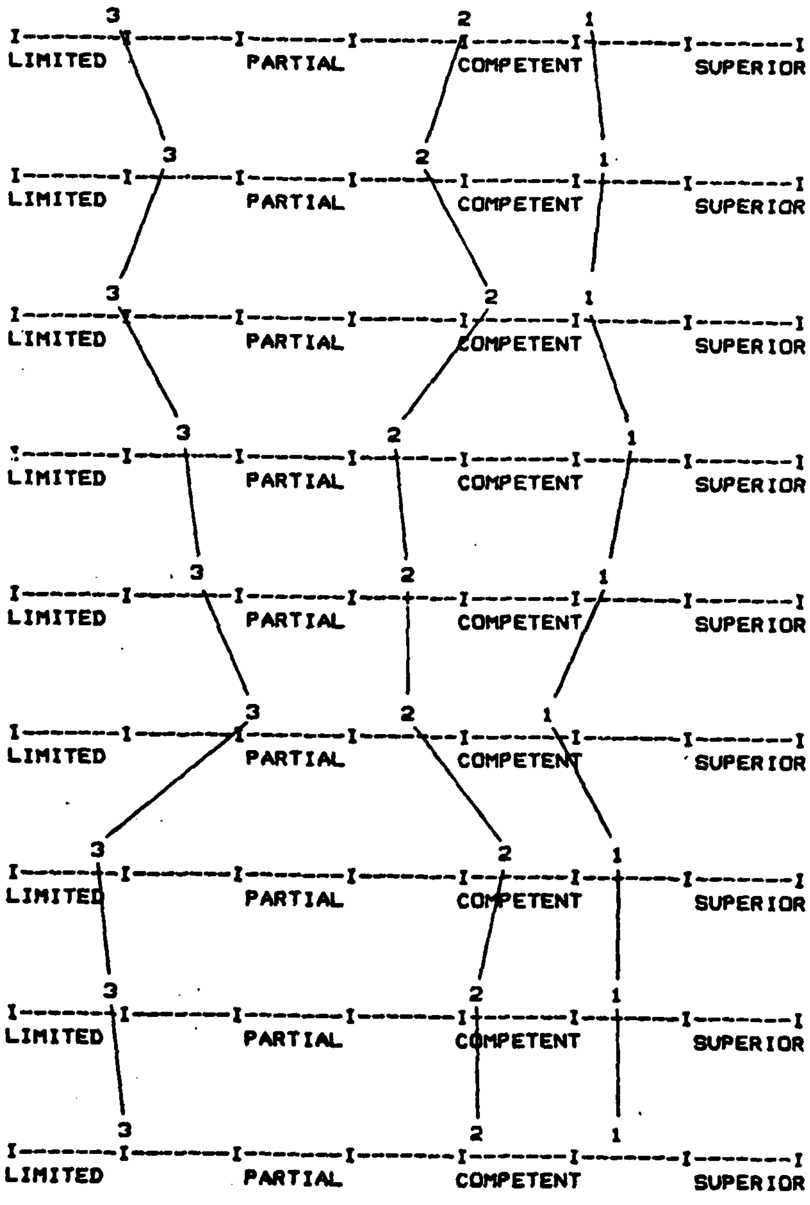
DIFFICULT ST TASKS

Task	Time consuming
LOCALIZE/ISOLATE SONAR MODULATOR-SCANNER MALFUNCTION TO THE MODULE/CARD LEVEL	TIME CONSUMING: 0% SQS-26 SQS-23
LOCALIZE/ISOLATE SONAR MODULATOR-SCANNER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 0% SQS-26 SQS-23
TEST/INSPECT SONAR AMPLIFIER-MODULATOR	TIME CONSUMING: 0% SQS-26 SQS-23
REMOVE/REPLACE CONVERTER B-SCAN COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 0% SQS-26
LOCALIZE/ISOLATE SONAR AMPLIFIER-MODULATOR MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 0% SQS-26 SQS-23
ESTIMATES PROBABLE LOCATIONS OF LOST CONTACTS USING TIME-LATE AND FINAL CONTACT DATA	TIME CONSUMING: 9% SQS-35 SQS-26 SQS-23
CHANGE SYSTEM CONFIGURATION BY PATCHING OR BY SWITCHBOARD CHANGES	TIME CONSUMING: 33% SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST CONSOLE 3	TIME CONSUMING: 14% SQS-26
MODIFY EQUIPMENT IN ACCORDANCE WITH SHIPALTS, ORDALTS, FIELD CHANGE ORDERS AND ELECTRONIC INFORMATION BULLETINS (EIBS)	TIME CONSUMING: 23% SQS-35 SQS-26 SQS-23



DIFFICULT ST TASKS



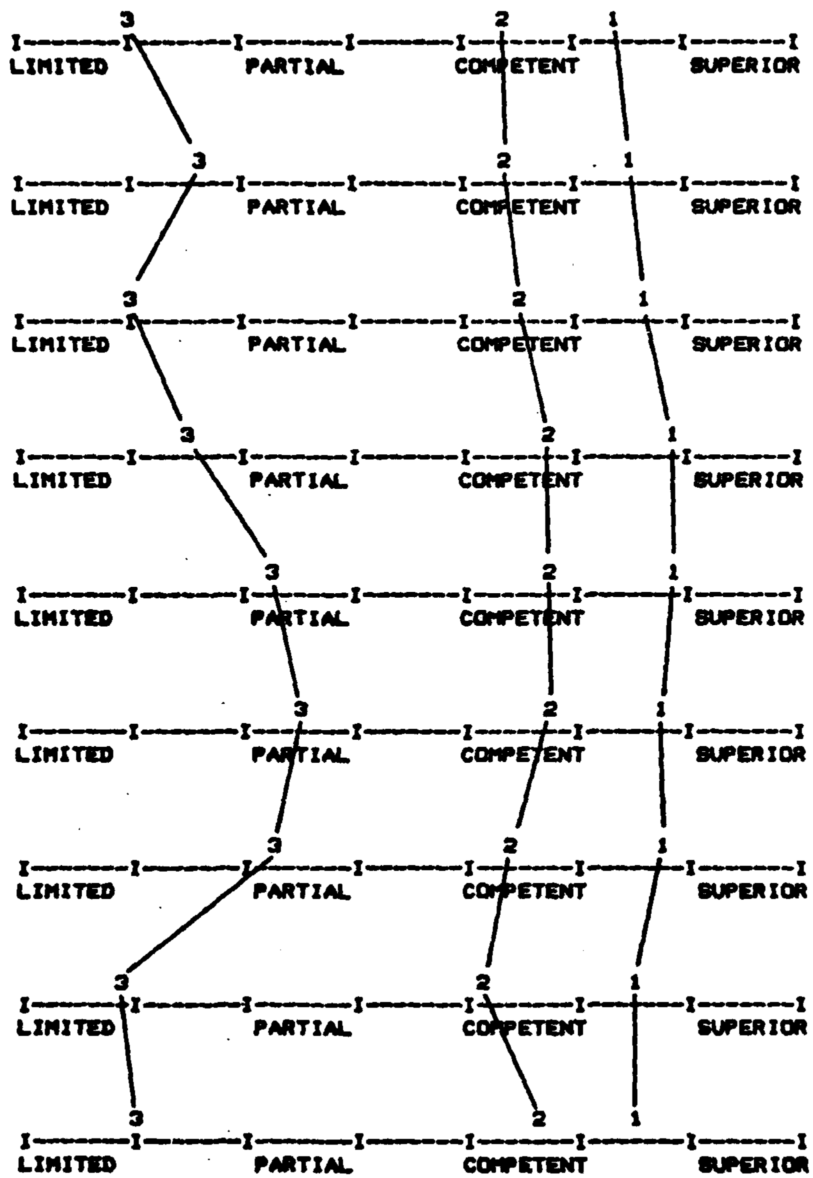
LOCALIZE/ISOLATE CONSOLE 2 MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 10%	SQS-35 SQS-26 SQS-23
ALIGN/ADJUST MECHANICAL LINKAGES AND GEAR TRAINS	TIME CONSUMING: 37%	SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST SCAN SWITCH CONVERTER	TIME CONSUMING: 28%	SQS-26 SQS-23
USES PUBLICATIONS CONCERNING OCEANOGRAPHIC AND METEOROLOGICAL CONDITIONS TO DETERMINE THE BEST PROPAGATION PATH TO UTILIZE (SUCH AS DIRECT, BOTTOM REFLECTED, CONVERGENCE ZONE)	TIME CONSUMING: 16%	SQS-35 SQS-26 SQS-23
DISTINGUISHES BETWEEN MOVING AND NON-MOVING TARGETS USING THE SONAR DISPLAYS ONLY	TIME CONSUMING: 13%	SQS-35 SQS-26 SQS-23
MAKES PASSIVE SONAR DETE('ION RANGE PREDICTIONS USING FOM	TIME CONSUMING: 16%	SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST PHASE CHANGING NETWORK	TIME CONSUMING: 33%	SQS-26 SQS-23
LOCALIZE/ISOLATE TRANSMITTER-RECEIVER SWITCH MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 23%	SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST SONAR SIGNAL PROCESSOR	TIME CONSUMING: 18%	SQS-35 SQS-26 SQS-23

DIFFICULT ST TASKS

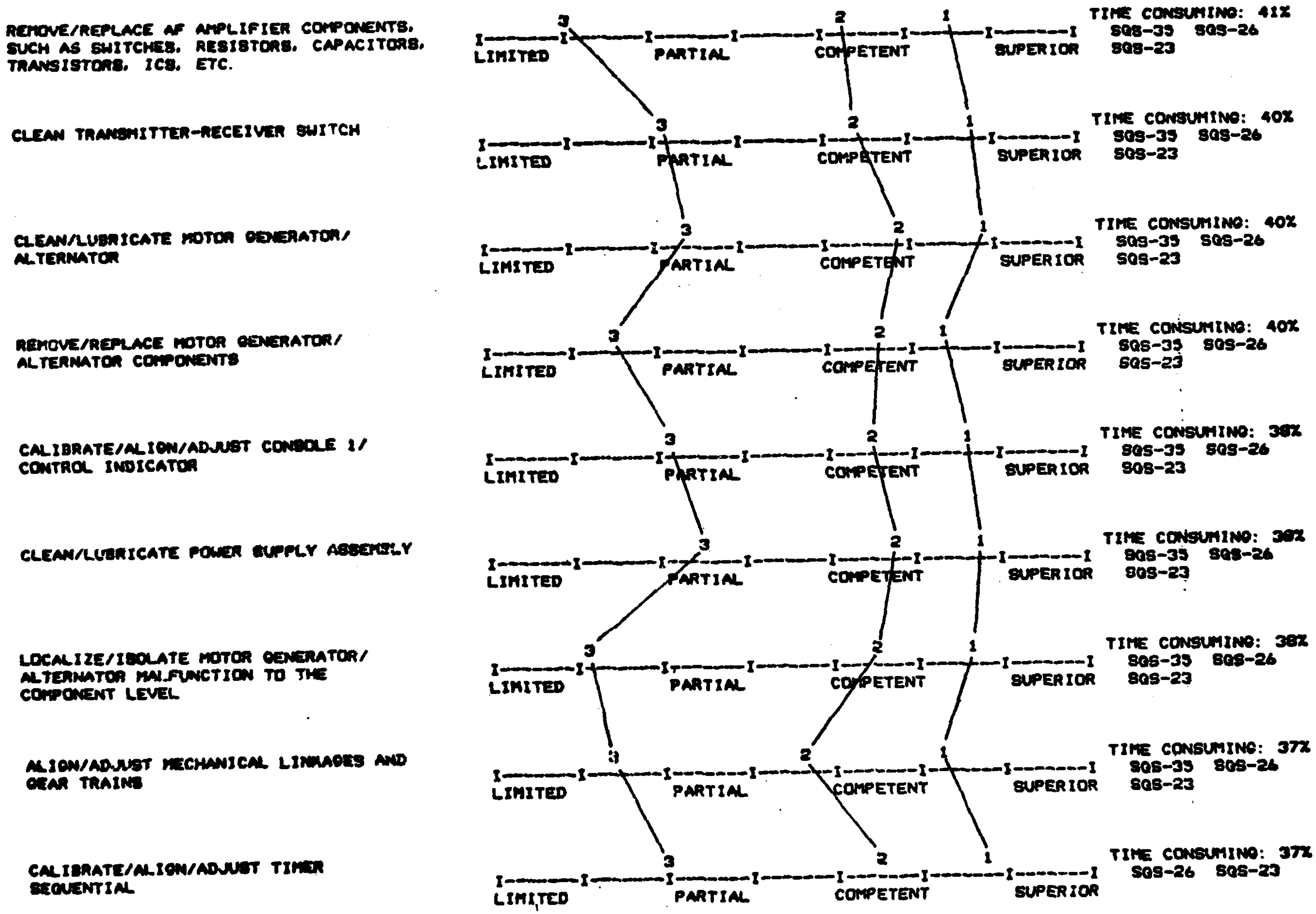
Task	Scale				Time consuming
	LIMITED	PARTIAL	COMPETENT	SUPERIOR	
LOCALIZE/ISOLATE CONVERTER A-SCAN MALFUNCTION TO THE MODULE/CARD LEVEL	3		2	1	TIME CONSUMING: 14% SQS-26
LOCALIZE/ISOLATE CONSOLE 3 MALFUNCTION TO THE MODULE/CARD LEVEL	3		2	1	TIME CONSUMING: 0% SQS-26
CORRELATES OWN SHIP SONAR DATUM WITH DATA FROM OUTSIDE SOURCES	3		2	1	TIME CONSUMING: 25% SQS-35 SQS-26 SQS-23
CALIBRATE/ALIGN/ADJUST CONVERTER A-SCAN	3		2	1	TIME CONSUMING: 42% SQS-26
LOCALIZE/ISOLATE PULSE SWEEP GENERATOR MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3		2	1	TIME CONSUMING: 11% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE AF AMPLIFIER MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3		2	1	TIME CONSUMING: 35% SQS-35 SQS-26 SQS-23
LOCALIZE/ISOLATE CONSOLE 3 MALFUNCTION TO THE COMPONENT LEVEL SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3		2	1	TIME CONSUMING: 14% SQS-26
LOCALIZE/ISOLATE TIMER SEQUENTIAL MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3		2	1	TIME CONSUMING: 12% SQS-26 SQS-23
LOCALIZE/ISOLATE TRANSMITTER CONTROL MALFUNCTION TO THE COMPONENT LEVEL, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	3		2	1	TIME CONSUMING: 20% SQS-26 SQS-23

TIME CONSUMING ST TASKS

REMOVE/REPLACE PHASE CHANGING NETWORK COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 66%	SGS-26 SGS-23
CALIBRATE/ALIGN/ADJUST MOTOR GENERATOR/ALTERNATOR	TIME CONSUMING: 53%	SGS-35 SGS-26 SGS-23
TEST/INSPECT PHASE CHANGING NETWORK	TIME CONSUMING: 50%	SGS-26 SGS-23
REMOVE/REPLACE POWER SUPPLY ASSEMBLY COMPONENTS, SUCH AS SWITCHES, RESISTORS, CAPACITORS, TRANSISTORS, ICS, ETC.	TIME CONSUMING: 46%	SGS-35 SGS-26 SGS-23
CALIBRATE/ALIGN/ADJUST POWER SUPPLY ASSEMBLY	TIME CONSUMING: 46%	SGS-35 SGS-26 SGS-23
CLEAN SONAR AMPLIFIER-SCANNER	TIME CONSUMING: 45%	SGS-35 SGS-26 SGS-23
CALIBRATE/ALIGN/ADJUST SONAR RECEIVER-SCANNER	TIME CONSUMING: 44%	SGS-35 SGS-26 SGS-23
CALIBRATE/ALIGN/ADJUST CONVERTER A-SCAN	TIME CONSUMING: 42%	SGS-26
REMOVE/REPLACE SIGNAL DATA CONVERTER	TIME CONSUMING: 41%	SGS-26 SGS-23



TIME CONSUMING ST TASKS



SECTION 8

TRAINING REQUIREMENTS AND NECs

ADDRESSING QUESTION 8

> What operational and maintenance training requirements are generated by the tasks to be performed? Can these be met by existing resources?

The identification of operational and maintenance training requirements generated by the proposed new system design will be aided by the previously performed task and skill level analyses. However, the question of necessary training resources and associated costs must also be addressed (see Figure 17).

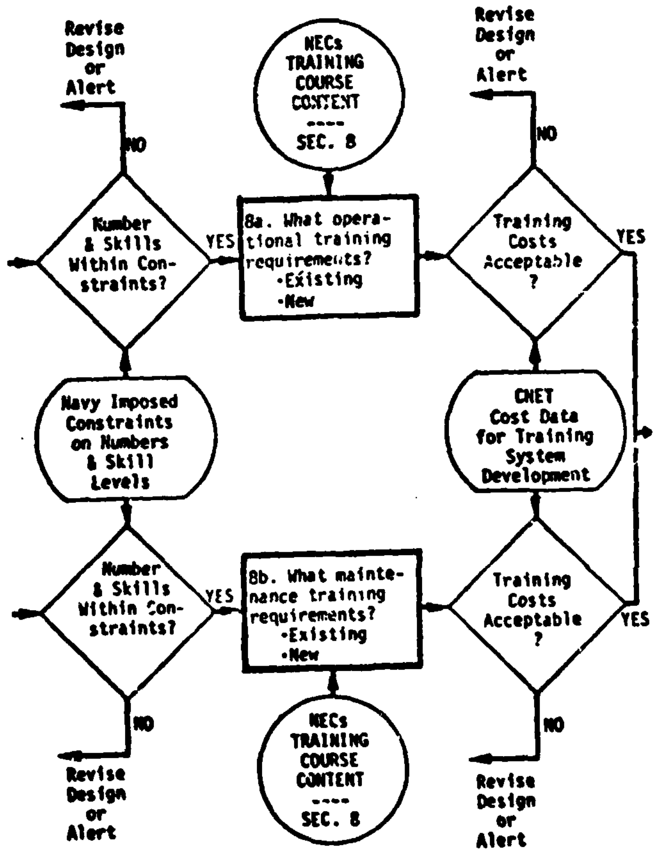


Figure 17. Addressing Question 8.

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AN ENGINEER'S GUIDE TO THE USE OF HUMAN RESOURCES IN ELECTRONIC--ETC(U)
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To the extent that the selected design minimizes the generation of new or more complex tasks, it may be possible to minimize training costs by utilizing existing training resources. The task taxonomies in Section 6 provide a convenient inventory of "old" tasks as a point of departure. Many of these tasks probably will be applicable to the new system as well. Where they do apply, existing training curricula, training aids, devices, and facilities may also be applicable, with resultant savings in cost.

Wherever a task not found in Section 6 is required, a new training requirement exists; and, when the number of new tasks becomes substantial, a requirement for a new NEC, with all its associated costs, is born.

> Data on the lifecycle costs of training Navy personnel for new NECs are currently being developed.

The Navy Personnel Research and Development Center is presently sponsoring work aimed at identifying lifecycle NEC costs and methods for estimating the relative costs of new training systems. These data will be added to this section in a future modification to this guide.

> A survey of existing NECs and associated training courses will provide some of the information needed to assess the applicability of existing training resources.

The system designer and the project manager should be aware of existing courses, devices, and facilities that can possibly serve to meet, in part at least, the training requirements of the proposed new system. One way of approaching this question is through a review of NECs for existing equipment similar in purpose to that under development, since many NECs have an associated specialized training course. To simplify this process, all current NECs relating to electronic systems operated or maintained by DS, ET, FTM, RM, or STG personnel have been listed on the following pages.

A catalog of all existing Navy training courses is maintained by the Naval Education and Training Command. This information is in a computerized data bank (CANTRAC) which can be accessed by a variety of key words such as type of system, equipment designator, NEC code, and so forth. Through this source, the designer or program manager can quickly obtain a listing of all established training courses, their durations, required prerequisites, etc., that apply to systems similar to the one under development.

Though this information will be of some help, it will not convey needed data on the comprehensiveness of instruction in particular areas of knowledge or skill acquisition. Unfortunately, this much needed information is not available as yet in a form for use by system designers.

SELECTED ENLISTED CLASSIFICATIONS (NECS) (SOURCE: NAVPERS 18068D, SECTION II, JANUARY 1977)

Data Systems Technician (DS)

- ET-1451 Satellite Metrological Data Terminal (SQM-10) and Navy Transportable Metrological Data Terminal Technician, ET DS
- ET-1471 Navigational Satellite System (SRN-9) TECHNICIAN, ET DS
- DS-1615 Shipboard Tactical Data Systems Technician, DS
- DS-1616 Data Display Equipment Maintenance Technician, DS
- DS-1618 Data Correlation and Transfer System Technician, DS
- DS-1623 Data Link Technician, DS
- DS-1634 Land Based Tactical Support Center Data Systems Technician, DS
- DS-1636 UYK-4(V) Computer System Maintenance Technician, DS
- DS-1645 FLTSATCOM (SSIXS/ISABPS) - OPCONCEN Maintenance Technician, DS
- DS-1653 IOIC Systems Maintenance Technician, DS
- DS-1655 CV-Tactical Support Center Computer Systems Technician, DS
- DS-1665 UYA-4 Data Display Equipment Maintenance Technician, DS
- DS-1666 UYK-5(V) Computer System Maintenance Technician, DS
- DS-1667 UYK-7 Computer and Associated Peripheral Technician, DS
- DS-1668 USQ-20(V) Peripheral Equipment Maintenance Technician, DS
- DS-1669 UYK-5 System and IBM Ancillary Equipment Technician, DS
- DS-1671 FFG-7 Class Computer/Peripheral Technician, DS
- DS-1672 DD-963 Class Computer/Peripheral Technician, DS
- DS-1673 LHA Class Computer and Associated Subsystems Technician, DS
- DS-1681 FFG-7 Class Display Equipment Maintenance Technician, DS
- DS-1682 DD-963 Class Display Equipment Maintenance Technician, DS
- DS-1683 CGN-38 Class Display Equipment Maintenance Technician, DS
- DP-2762 Punched Card Accounting Machine (PCAM) Repairman, DP DS ET

Electronics Technician (ET)

- ET-1403 Communications Equipment (FRT-83/84/85) Technician, ET
- ET-1404 Communications Equipment (TROPO-SCATTER) Technician, ET
- ET-1405 Communications Equipment (FRT-39, URT-19, and URA-30) Technician, ET

ET-1406 Communications Equipment (FRR-60 Radio Receiver & CU-1382/UR Multicoupler) Technician, ET
ET-1407 Communications Equipment (FTA-15 & FGC-60 Technician, ET
ET-1408 Communications Equipment (FRC-84 & FCC-17) Technician, ET
ET-1409 FCG-73 & UGR-14 (Inktronic Page Printer) Repairman, ET
ET-1411 Digital Subscriber Terminal Equipment Maintenance Technician, ET
ET-1412 Special Fixed Communications Maintenance Technician, ET
ET-1413 Meteorological/Oceanographic Equipment Maintenance Technician, ET
ET-1414 Communications Equipment (VLF/LF) Technician, ET
ET-1415 Shore Transmitter Facility Maintenance Technician, ET
ET-1416 Shore Receivers Facility Maintenance Technician, ET
ET-1417 ASCOMM/TSC Communications Systems Technician, ET
ET-1421 Communications Equipment (WRT-2) Technician, ET
ET-1422 Communications Equipment (UCC-1) Technician, ET
ET-1423 Communications Equipment (SRC-20/21 & URC-9) UHF Technician, ET
ET-1424 Communications Equipment (VRC-46/SRA-60/VCC-2) Technician, ET
ET-1426 Communications Equipment (Tactical Data Systems SRC-16/17/23/31) Technician, ET
ET-1427 Communications Equipment (Tactical Data Systems) Technician (SRC-16/23, URC 85), ET
ET-1431 Communication Security Devices Equipment (KY-8) Technician, ET CTM RM (SS)
ET-1432 Communication Security Devices Equipment (KW-37T) Technician, ET CTM
ET-1433 Communication Security Devices (Steam Valve Maintenance) Technician, ET
ET-1434 Communication Security Devices Equipment (KG-13) Technician, ET CTM
ET-1435 Communication Security Devices Equipment (KW-37R, KW-7) Technician, ET RM (SS)
ET-1436 Communication Security Devices Equipment (KG-14, KW-37R) Technician, ET CTM RM (SS)
ET-1437 Communication Security Devices Equipment (FW-37R) Technician, ET CTM RM (SS)
ET-1438 Communication Security Devices Equipment (KW-7) Technician, ET CTM AT RM (SS)
ET-1441 Communication Security Devices Equipment (KW-26) Technician, ET CTM
ET-1442 KG-30 Family Limited Maintenance Technician, ET CTM RM (SS)
ET-1443 KG-30 Family Unlimited Maintenance Technician, ET
ET-1447 Communication Security Devices Equipment (KY-28) Technician, ET AT RM
ET-1448 Communication Security Devices Equipment (KY-3) Technician, ET CTM
ET-1449 NBST Equipment Technician, ET CTM

ET-1451 Satellite Metrological Data Terminal (SQM-10) & Navy Transportable Metrological Data Terminal Technician, ET DS
ET-1453 FLTSATCOM (NAVMACS A+ - WSC-3) Shipboard Maintenance Technician, ET
ET-1454 DD-963 Communications Systems Technician, ET
ET-1455 FLTSATCOM (CUDIXS - WSC-5) Shipboard Maintenance Technician, ET
ET-1456 FLTSATCOM (CUDIXS - NAVCOMMSTA) Maintenance Technician, ET
ET-1461 Special Maintenance (FSC-78/79 SHF Satellite Terminal) Technician, ET
ET-1462 Special Maintanance (MSC-46 Satellite Communications) Technician, ET
ET-1463 Special Maintenance (TSC-54 Satellite Communications) Technician, ET
ET-1464 Special Maintenance (WSC-5 Satellite Terminal) Technician, ET AT
ET-1466 Special Maintenance (SSC-6 Major SHF SATCOM Terminal) Technician, ET
ET-1471 Navigational Satellite System (SRN-9) Technician, ET DS
ET-1472 Tactical Air Navigation (SRN6/URN3/GRN9) Technician, ET
ET-1473 Tactical Air Navigation (URN-20) Technician, ET
ET-1474 Inertial Navigation MK 11 MOD 1 SINS (N7B) Technician, ET
ET-1475 Inertial Navigation MK III MOD 4 SINS Technician, ET
ET-1476 Inertial Navigation MK III MOD 6 SINS Technician, ET
ET-1477 Inertial Navigation (SNAIAS) Technician, ET
ET-1478 Dual Miniaturized Inertial Navigation System (DMINS) Technician, ET
ET-1479 DD-963 Navigation Equipment Technician, ET
ET-1481 Electronic Warfare Support Measures (ESM) (WLR-1 Series) System Technician, ET CTM
ET-1482 Electronic Warfare System Technician (WLR-6), ET CTM
ET-1483 Electronic Warfare System Technician (WLR-8(V-2)), ET
ET-1484 Electronic Warfare System Technician (BRD-7), ET CTM
ET-1501 Basic Electronics Maintenanceman, ET
ET-1502 Radar (SPN-41, SPN-43, & SPN-44) Technician, ET
ET-1503 Radar (SPS-49) Technician, ET
ET-1504 Radar (SPS-55) Technician, ET
ET-1505 Radar (SPS-29C) Technician, ET
ET-1506 Radar (SPS-29E) Technician, ET
ET-1512 Radar Systems (SPS-37A & SPS-43A) Technician, ET
ET-1513 Fixed Array Radar (FAR) Technician, ET
ET-1514 Radar (SPS-40) Technician, ET
ET-1515 Radar (SPS-40A) Technician, ET
ET-1516 Radar (SPS-40B) Technician, ET
ET-1517 Radar Repeater Systems Maintenance Technician, ET
ET-1519 Radar (SPS-30) Technician, ET
ET-1521 Radar (SPN-10) Technician, ET
ET-1522 Radar (SPN-42) Technician, ET
ET-1523 Radar (SPN-35/35A) Technician, ET

ET-1524 Radar (SPN-6/12) Technician, ET
ET-1561 Special Maintenance (Teams) Technician, ET
ET-1572 AIMS System Technician, ET
ET-1573 AIMS (TSEC/CRYPTO) Technician, ET AT
ET-1574 DAIR/GCA (TPX-42, CPN-4) Maintenance Technician, ET
EW-1717 Electronic Warfare Systems (SLO-20, ALQ-91) Technician, EW ET
DP-2762 Punched Card Accounting Machine (PCAM) Repairman, DP DS ET
-3301 Fleet Ballistic Missile Weapons & Navigation System Technician-Special Category, FTB MT ET TM
-3325 Inertial Navigation Systems MK II MOD 6 Technician, ET
-3332 NAVDAC MK II MOD 2/4: SDC MK III MODO/1 Technician, ET
-3333 Central Navigation Computer Technician, ET
-3337 Navigation Aids Technician, ET
-3338 ESGM Navigation Aids Technician, ET
IC-4746 Closed Circuit TV Technician, IC TD ET

Fire Control Technician (FTM)

FT-1101 MK 92 MOD 1 Gunfire Control System Technician, FTM FTG
FT-1102 MK 92 MOD 2 Gun & Missile Fire Control System Technician, FTM FTG
FT-1105 SPG-55B (Track) Radar Technician, FTM
FT-1106 AEGIS Fire Control System MK 99//Weapon Control System MK 1 Technician, FTM
FT-1107 AEGIS Radar System (SPY-1A) Technician, FTM
FT-1108 AEGIS Weapon System MK 7 Technician, FTM
FT-1109 TERRIER Missile Fire Control System (MK 76 MODS 6, 7, & 8) Technician, FTM
FT-1113 TARTAR WDS MK 4 Technician, FTM
FT-1118 TERRIER WDS MK 3, 5, & 7 Technician, FTM
FT-1119 TALOS WDS MK 6 Technician, FTM
FT-1135 Search Radar (SPS-39, 39A or 42) Technician, FTM
FT-1136 Search Radar (SPS-48A) Technician, FTM
FT-1137 Search Radar (SPS-52) Technician, FTM FTG
FT-1139 Search Radar (SPS-48) Technician, FTM FTG
FT-1143 TALOS Equipment Maintenance Technician, FTM
FT-1144 TARTAR/TERRIER Equipment Maintenance Technician, FTM
FT-1146 Basic Point Defense SMS Technician, FTM
FT-1148 Improved Point Defense Guided Missile Fire Control System MK 91 MOD 0 Technician, FTM
FT-1153 TARTAR MK 74 Digital Update Weapons Control System Technician, FTM
FT-1154 TARTAR MK 74 MOD 4 WDS MK 11 Weapons System Technician, FTM
FT-1156 TERRIER MK 76 WDS MK 11 Weapons System Technician, FTM
FT-1157 TERRIER MK 76 Weapons Control System Technician, FTM
FT-1158 TALOS MK 77 Weapons Control System Technician, FTM
FT-1159 TARTAR MK 74 Weapons Control System Technician, FTM
FT-1161 Fire Control Radar (SPW-2) Technician, FTM
FT-1163 Fire Control Radar (SPG-49) Technician, FTM
FT-1164 Fire Control Radar (SPG-51) Technician, FTM
FT-1165 Fire Control Radar (SPG-55) Technician, FTM

FT-1166 Radar (SPG-51C) (Digital Update) Technician, FTM
FT-1167 Fire Control Radar (SPW-2, SPG-49) Technician, FTM
FT-1168 Radar (SPG-51D) Technician, FTM
FT-1169 TERRIER (SPG-55B) CWAT Radar Technician, FTM
FT-1183 TARTAR MK 74 MOD 4 & 8 MFCS Computer Complex Technician, FTM
FT-1184 TARTAR Fire Control Computer MK 118 Technician, FTM
FT-1185 TERRIER Fire Control Computer MK 119 Technician, FTM
FT-1186 TALOS Fire Control Computer MK 111 MOD 1 Technician, FTM
FT-1187 TALOS Fire Control Computer MK 152 Complex Technician, FTM
FT-1188 TARTAR Fire Control Computer MK 152 Complex Technician, FTM
FT-1189 TERRIER Fire Control Computer MK 152 Complex Technician, FTM

Radioman (RM)

ET-1431 Communication Security Devices Equipment (KY-8) Technician, ET CTM RM (SS)
ET-1435 Communication Security Devices Equipment (KW-37R, KW-7) Technician, ET RM (SS)
ET-1436 Communication Security Devices Equipment (KG-14, KW-37R) Technician, ET CTM RM (SS)
ET-1437 Communication Security Devices Equipment (KW-37R) Technician, ET CTM RM (SS)
ET-1438 Communication Security Devices Equipment (KW-7) Technician, ET CTM AT RM (SS)
ET-1442 KG-30 Family Limited Maintenance Technician, ET CTM RM (SS)
RM-2301 Enlisted Frequency Manager, RM
RM-2304 Intermediate Radio Operator, RM
RM-2305 DCS Sate-lite Communication Terminal Operator (MSC-46 and/or TSC-54), RM CTO
RM-2313 Communications Systems Manager, RM
RM-2314 Cryptographic Machines Repairman, RM CTM CTO
RM-2318 Communication System Technical Operator, RM CTO
RM-2319 Communication System Technical Supervisor, RM CTO
RM-2342 Teletype (MOD 28, UGC-6 & UGC-20) Repairman, RM CTM CTO
RM-2345 Teletype (UGC-20/25) Repairman, RM CTM CTO
RM-2351 FLTSATCOM (NAVMACS A+) Shipboard Operator, RM
RM-2354 FLTSATCOM (SSIXS-OPCONCEN) Operator, RM
RM-2355 FLTSATCOM (CUDIXS) NAVCOMMSTA Operator, RM
RM-2359 ASCOMM Operator, RM
RM-2361 SHF SATCOM Terminal (FSC-78/79) Operator, RM
RM-2368 FLTSATCOM Technical Control Operator, RM CTO
RM-2369 FLTSATCOM Technical Control Supervisor, RM CTO
RM-2371 Automated Communications Systems Operator, RM
RM-2372 Automated Communication Systems Computer Console Operator, RM
RM-2393 Special Fixed Communication System Operator, RM
DP-2746 System Programmer (LDMX/NAVCOMMPARS), DP RM

Sonar Technician (STG)

ST-0431 Underwater Fire Control MK 111 ASROC Technician, STG
ST-0434 Underwater Fire Control MK 114 ASROC Technician, STG
ST-0435 Underwater Fire Control MK 114 MOD 9 TERRIER/ASROC Technician, STG
ST-0437 Underwater Fire Control MK 116 ASROC Technician, STG
ST-0438 Underwater Fire Control MK 116 MOD 1 Technician, STG
ST-0439 Underwater Fire Control MK 105 MODS 11-28 Technician, STG
ST-0445 Surface Acoustic Analyst, STG
ST-0446 Acoustic Processor (SQS-54) Technician, STG
ST-0447 Acoustic Processor (SQR-17) Technician, STG
ST-0451 Surface Sonar (SQS-23) Technician, STG
ST-0452 Surface Sonar (SQS-26BX)(EDO) Technician, STG
ST-0453 Surface Sonar (SQS-26AX)(R) Technician, SRG
ST-0454 Surface Sonar (SQS-26CX) Technician, STG
ST-0455 Surface Sonar (SWS-23) H-L Maintenance, STG
ST-0456 Surface Sonar (SQS-35 IVDS)(SQA-13 HOIST) Technician, STG
ST-0457 Surface Sonar (SQS-53) Technician, STG
ST-0458 SQS-56 Sonar Set Shipboard Maintenance Technician, STG
ST-0459 Surface Sonar (SQQ-23 Pair) Technician, STG
ST-0473 Surface Sonar/ASW Fire Control System MK 116 MOD 1 (SQS-53) Technician, STG
ST-0474 Surface Sonar/ASW Fire Control System MK 116 MOD 0 ASROC (SQS-53) Technician, STG
ST-0475 Surface Sonar/ASW Fire Control System MK 111 ASROC (SQQ-23) Technician, STG
ST-0477 Surface Sonar/ASW Fire Control System MK 114 ASROC (SQQ-23) Technician, STG
ST-0478 ASW Fire Control Panel MK 309 Maintenance Technician, STG
ST-0479 SQS-56 Sonar Set Shipboard & ASW Fire Control Panel MK 309 Maintenance Technician, STG
ST-0481 Surface Sonar/ASW Fire Control System MK 114 ASROC (SQS-26AX) Technician, STG
ST-0482 Surface Sonar/ASW Fire Control System MK 114 ASROC (SQS-26BX) Technician, STG
ST-0483 Surface Sonar/ASW Fire Control System MK 114 ASROC (SQS-26CX) Technician, STG
ST-0484 Surface Sonar/ASW Fire Control System MK 114 ASROC (SQS-23) Technican, STG
ST-0487 Surface Sonar/ASW Fire Control System MK 111 ASROC (SQS-23) Technician, STG
ST-0491 Surface Sonar/ASW Fire Control System MK 114 MOD 9 TERRIER/ASROC (SQS-26AX) Technician, STG
ST-0492 Surface Sonar/ASW Fire Control System MK 114 MOD 9 TERRIER/ASROC (SQS-26BX) Technician, STG
ST-0496 Surface Sonar/ASW Fire Control System MK 105 (SQS-23) Technician, STG

SECTION 9

BILLET LIFECYCLE COSTS FOR REQUIRED PERSONNEL

ADDRESSING QUESTION 9

What are the estimated lifecycle costs for the personnel required to operate and maintain the system? Are these within Navy imposed constraints?

This section provides data for estimating personnel lifecycle costs for selected system lifecycles (1, 5, 10, 15, and 20 years) as a function of required personnel skill levels (pay grade). These data will enable the designer to answer Question 9 as shown in Figure 18.

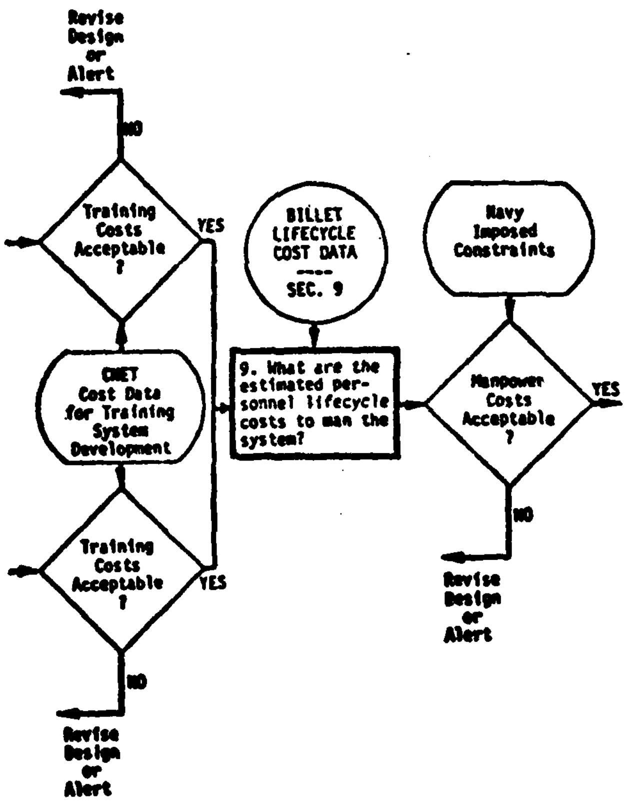

Figure 18. Addressing Question 9.

The cost data, shown separately for DS, ET, FTM, RM, and ST personnel, have been selected from a more comprehensive source document which contains lifecycle costs information for a more general group of Navy ratings.*

SOURCE OF THE DATA

> The cost data are derived from the Billet Cost Model.

The cost data presented in this section are based upon information available in the Billet Cost Model, which was developed and is being maintained by OPNAV 135. The structure and format of the data base for the Billet Cost Model were developed in 1966 by the SECNAV Task Force on Personnel Retention. Over the years, adjustments have been made in that data base to cope with changing data sources, formats, and availability and to take advantage of new information as it has become available.

The data elements and sources used in computing the lifecycle costs are itemized in Table 4. As shown, the primary sources of data are the various budget documents that provide information for the past reporting period as well as justification for, and some detail on, money requirements for the upcoming period. After the expenditures have been identified, they are distributed to the ratings wherever possible--a critical step that results in cost differentiation among ratings. Those that are not applicable to a given rating are applied equally across all ratings in the annual cost by year or grade element (Koehler, 1979).

*Koehler, E. A. Life Cycle Navy Enlisted Billet Costs--FY79 (Spec. Rep. 79-13. San Diego: Navy Personnel Research and Development Center, March 1979.

Table 4

Factors Included in Billet Cost Model Computations

Data Element	Action/Source
Base Pay	1 Oct 1978 OASD(MRA&L) MPP[a]
Clothing Allowance	MPN/Pay Manual
Command and Administration	O&MN
Commissary	O&MN
Death Gratuity	MPN
Dependent School	DoD Dependent School Office
Disability	MPN
E-7 Clothing Allowance	MPN
Family Separation Allowance	MPN
FICA	6.02% of first $17,500 from SSA
Hazard Pay	MPN
Insurance/Housing (FHA)	DoD McClary Report
Medical Costs	BUMED Comptroller; O&MN, Budget Activity 8
Messing Subsistence	MPN/Pay Manual
Overseas Station Allowance	MPN
Prisoner Apprehension	MPN
Procurement Personnel	MPN
Pro-Pay	Not updated, not available from JUMPS yet (small variations in ratings this year)
Quarters Allowance	Imputed value from MPN for MILCON equivalent for base housing; MPN Pay Table for off-base housing
Recreation Facilities	In Command/Administration above
Recruiting Costs	O&MN
Reenlistment Bonus	Computed from JUMPS data by rating[b]
Retirement	Computed from force statistics and entitlements from Pay Manual
School Costs	O&MN
Sea and Foreign Duty Pay	MPN
Severance	MPN
Travel	MPN tied to move patterns by grade

[a]MPN/O&MN budgets are from Congressional Submit., January 1978; Pay Manual is DoD Military Pay, Entitlements, Allowance Manual, 1968, as amended.

[b]JUMPS is Joint Uniform Military Pay Systems.

DETERMINATION OF SPECIFIC BILLET COSTS

How can the costs of specific personnel requirements be computed?

Using the billet cost information for the applicable ratings, the designer employs his estimate of the number and the rating level (E-2 through E-9) of the personnel needed and the number of years that he anticipates the system will be operational. Most system, especially the kind addresses in this guide, have skill requirements equivalent to pay grades ranging from E-4 (entry level operator or maintainer) to E-7 (highly experienced evaluator).

To illustrate, if it is decided that one 3rd class DS (E-4) will be required and that the system will be operational for 15 years, the analyst should locate that pay grade in the first column of Table 5 and read across the row until he comes to the column for the 15-year period. As shown in the table, the lifecycle billet cost for such a manpower resource would be $212,721 for each such individual required.

Using this costing information in computing lifecycle costs sometimes leads to counter-intuitive results. The data nevertheless reflect actual cost differences based on fact. For example, within some ratings, there are only slight differences in costs between some of the pay grades or even reversals between two pay grades (e.g., the average billet costs for an FTM at the E-8 level is somewhat more than at the E-9 level). This is because differences in expenditures such as those for training have altered the relative costs.

COMPUTING TOTAL SYSTEM MANPOWER COSTS

How are the costs of all system operator and maintainer personnel computed?

Table 5
Billet Life Cycle Cost Data

Rating	Pay Grade	Years[a] 1	5[a]	10[a]	15[a]	20[a]
DS	E-2	24812.	103463.	167705.	207595.	232363.
DS	E-3	29718.	123920.	200865.	248642.	278308.
DS	E-4	31472.	131234.	212721.	263317.	294734.
DS	E-5	35763.	149127.	241724.	299219.	334919.
DS	E-6	30484.	127114.	206043.	255051.	285482.
DS	E-7	35360.	147447.	239000.	295847.	331145.
DS	E-8	37531.	156499.	253674.	314011.	351476.
DS	E-9	36331.	151496.	245563.	303971.	340239.
ETN	E-2	15738.	65625.	106374.	131675.	147386.
ETN	E-3	16314.	68027.	110267.	136495.	152780.
ETN	E-4	19391.	80858.	131065.	162239.	181596.
ETN	E-5	20299.	84644.	137202.	169836.	190099.
ETN	E-6	21623.	90165.	146151.	180914.	202499.
ETN	E-7	24399.	101741.	164914.	204140.	228496.
ETN	E-8	27150.	113212.	183508.	227156.	254259.
ETN	E-9	29485.	122949.	199290.	246693.	276126.
ETR	E-2	18470.	77017.	124839.	154533.	172971.
ETR	E-3	19055.	79457.	128794.	159428.	178449.
ETR	E-4	22185.	92509.	149949.	185616.	207762.
ETR	E-5	21220.	88485.	143427.	177542.	198725.
ETR	E-6	24051.	100290.	162562.	201228.	225237.
ETR	E-7	26754.	111561.	180831.	223843.	250550.
ETR	E-8	29811.	124308.	201494.	249420.	279179.
ETR	E-9	32214.	134328.	217736.	269525.	301683.
FTM	E-2	28452.	118641.	192308.	238050.	266452.
FTM	E-3	29056.	121160.	196391.	243103.	272108.
FTM	E-4	34384.	143377.	232403.	287681.	322005.
FTM	E-5	31298.	130509.	211544.	261862.	293105.
FTM	E-6	30712.	128065.	207584.	256959.	287617.
FTM	E-7	46573.	194203.	314789.	389663.	436154.
FTM	E-8	46580.	194233.	314836.	389722.	436220.
FTM	E-9	39659.	165373.	268057.	331816.	371405.
RM	E-2	16011.	66764.	108219.	133960.	149942.
RM	E-3	16595.	69199.	112166.	138846.	155412.
RM	E-4	18799.	78389.	127063.	157286.	176052.
RM	E-5	17109.	71342.	115640.	143146.	160225.
RM	E-6	22428.	93522.	151592.	187649.	210037.
RM	E-7	25737.	107320.	173957.	215334.	241026.
RM	E-8	27695.	115485.	187192.	231716.	259363.
RM	E-9	29242.	121935.	197648.	244660.	273850.
STG	E-2	18729.	78097.	126590.	156700.	175396.
STG	E-3	19292.	80445.	130395.	161411.	180669.
STG	E-4	20965.	87421.	141703.	175408.	196336.
STG	E-5	33402.	139282.	225765.	279465.	312809.
STG	E-6	35146.	146554.	237553.	294057.	329141.
STG	E-7	36737.	153188.	248307.	307368.	344041.
STG	E-8	40698.	169705.	275079.	340509.	381135.
STG	E-9	40254.	167854.	272078.	336794.	376977.

[a]Cost figures for 5, 10, 15, and 20 years reflect a 10 percent discount rate. If discounted costs are not desired, use the "1" year cost multiplied by the number of years.

Table 5 can be used to compute the total manpower costs for the lifecycle of the system. Suppose it is concluded that a communication system design calls for an operator staff of two 3rd class RMs (E-4) and one 1st class RM (E-6). The analyst would make two computations, and add them together to find the total cost per unit.

Rating	Level	15-Year Lifecycle	Number of Men	Lifecycle Costs Per Unit
RM	E-4	127,063	2	$254,126
RM	E-6	151,592	1	$151,592
				$405,718

Next, the analyst must decide how many hours of each day the system must be manned. For example, if the system is to be operated continuously over a 24-hour period, the initial billet cost estimation per shift for the two E-4s and one E-6 (i.e., $405,718 must be multiplied by three to account for three 8-hour shifts:

$405,718 per shift x 3 shifts = 1,217,154 per unit.

Finally, the analyst must decide how much the lifecycle costs of maintenance personnel will add to the total manpower cost of the system. For example, if he estimates that the maintenance of the system will require a Data Systems Technician (DS) at the E-5 level for 8 hours and and an Electronics Technician [ET(N)] at the E-4 level for 4 hours a day, he would need to compute these costs and add them to the operational costs to determine the total estimated lifecycle billet costs per unit.

Rating	Level	15-Year Lifecycle	Number of Men	Lifecycle Costs Per Unit
DS	E-5	241,724	1.0	$ 241,724
ET(N)	E-4	131,065	0.5	$ 65,533
Operator Costs (as determined from previous example)				$1,217,154
			Total	$1,524,411

These estimated lifecycle billet costs do not include those cost items relating to systems management personnel, officer assignments,

and external military tasks. The data do, however, permit a more nearly accurate assessment of the lifecycle costs of operator and maintenance personnel than has previously been possible. They have been calculated using a 10% discount rate. If the analyst needs to employ a different rate, he should refer to the previously cited NPRDC report for a method of handling this problem.

SECTION 10

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